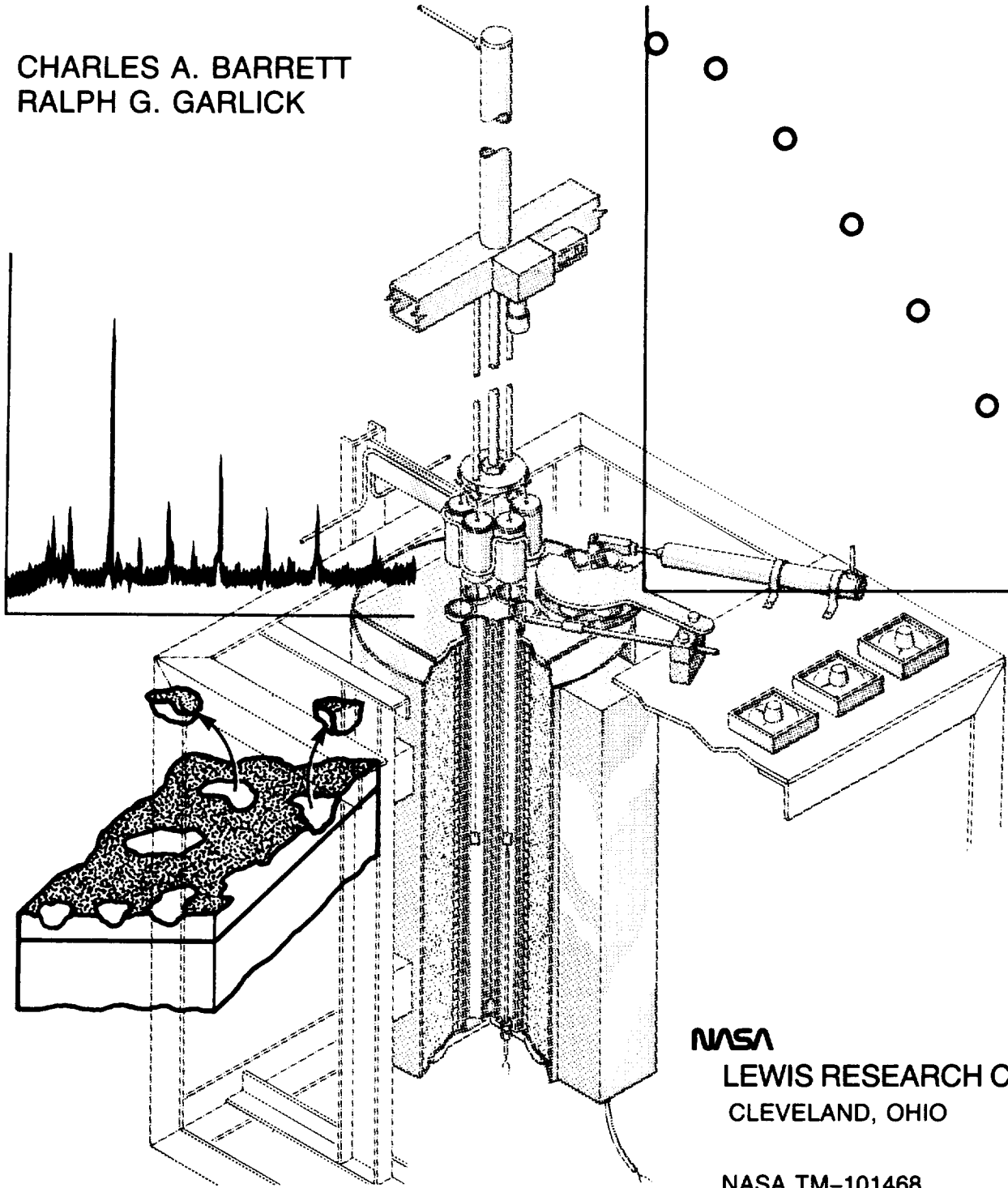


# HIGH-TEMPERATURE CYCLIC OXIDATION DATA

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RALPH G. GARLICK



(NASA-TM-101468) HIGH-TEMPERATURE CYCLIC  
OXIDATION DATA. PART 2: TURBINE ALLOYS  
(NASA) 452 P  
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**NASA**

LEWIS RESEARCH CENTER  
CLEVELAND, OHIO

NASA TM-101468

TURBINE ALLOYS, PART 2  
OCTOBER 1989



NASA Technical Memorandum 101468

# High-Temperature Cyclic Oxidation Data

## Turbine Alloys, Part 2

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*Cleveland, Ohio*

October 1989



National Aeronautics and  
Space Administration

**Lewis Research Center**  
Cleveland, Ohio 44135



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## Summary

This volume is the second part in a series of cyclic oxidation handbooks presenting cyclic oxidation data tested at NASA Lewis Research Center. It contains specific-weight-change-versus-time data and x-ray diffraction results derived from high-temperature cyclic tests for the remainder of high-temperature, high-strength nickel-base  $\gamma/\gamma'$  and cobalt-base turbine alloys tested at Lewis. Part 1 of the series is available as NASA Technical Memorandum 83665 (Rev. 1989).

## Introduction

The specific-weight-change-versus-time data and plots and associated x-ray data complete the presentation of the cyclic oxidation data for high-temperature nickel- and cobalt-base turbine alloys tested at NASA Lewis Research Center. The scope of this oxidation testing program is detailed in reference 1. The initial body of data for this class of alloys was presented in reference 2. The test rigs and method of deriving the specific-weight-change-versus-time data for the alloy test samples are also described in this reference. These gravimetric data are presented both in graphical and tabular form. X-ray diffraction analysis of the retained oxide scale as well as the accumulated scale spall performed after selected exposure times are also presented in tabular form.

The data are presented for 36 alloys listed in alphabetical order. There are 33 Ni-base alloys followed by 3 Co-base alloys. These alloys and their compositions are listed in table I. The hierarchical order sequence in the report for each alloy is from high to low temperature in degrees Celsius and from long to short cycle time, with the majority of test cycles (i.e., standard cycle) being 1.0 hr with a minimum of 20 min between cycles at ambient temperature. The samples were removed and weighed at as close to a standard schedule as possible (i.e., 1, 15, 30, 45, 60, 75, 90, 100, 115 hr, and so on). The cast alloys are listed before the hot-worked alloys. Under the cast heading, the conventionally cast alloys are listed before the directionally solidified. The number in the upper right corner is an internal NASA number giving the alloy code and run number (see ref. 1).

## Alloy Composition

The compositions of the 33 Ni-base and 3 Co-base alloys tested are listed in table I. In general, these are cast alloys, although a few such as Waspaloy, René 41, and U-520 are hot-worked wrought alloys. U-700 was used in many cases as a standard involving both cast and wrought forms. IN-738 also included one hot-worked alloy although it is usually a cast alloy. The comments column indicates whether more than one heat and/or vendors were involved. The cast alloys were generally in the as-cast condition. The alloy compositions listed are within 10 percent of actual heat or sample chemistries except where noted.

## Comments on the Data

In general, the specific-weight-change-versus-time cyclic oxidation data follow parabolic behavior; that is, the specific-weight-change values increase with time to a maximum, with roughly parabolic kinetics, and then reverse and drop in a linear manner with time. By regression analysis the data can be fitted to the model

$$\Delta W/A = k_1^{1/2} t_1^{1/2} - k_2 t \pm \sigma \quad (1)$$

where  $\Delta W/A$  is specific weight change,  $t$  is time,  $k_1^{1/2}$  is an oxide growth constant analogous to the parabolic growth constant derived in isothermal oxidation  $k_p^{1/2}$ , and  $k_2$  is a linear oxide spalling constant. This is a useful first-approximation model, particularly for these types of alloys, since an attack parameter defined as

$$K_a = (k_1^{1/2} + 10 k_2) \quad (2)$$

can be used to rank the cyclic oxidation resistance of the alloy. Over 90 percent of the data in this handbook can be fitted to equation (1) with an  $R^2$  of 90 percent or greater. ( $R^2$  is the coefficient of determination, defined as the percent of variation explained by the regression fit.) The remainder of the alloys can be fitted more directly to

$$\Delta W/A = -k_2 t \pm \sigma \quad (3)$$

Here  $K_a$  is defined as

$$K_a = 20 k_2 \quad (4)$$

These  $K_a$  values, together with the  $k_1^{1/2}$  and/or  $k_2$  values, have been discussed in detail in references 1 and 3 to 10.  $K_a$  values have been shown to correlate well with either metal loss due to conversion to oxide or thickness change as the alloy metal is depleted.  $K_a$  also has the advantage that it is relatively insensitive to the length of test as long as the oxidation mechanism does not change. Mechanism change usually means that a less protective scale becomes rate controlling, which leads to "breakaway," or catastrophic, failure.

A simpler method of evaluation is to compare specific weight change at a given time, say 100 or 200 hr. This is a very rough ranking method unless the spalling rate is relatively high. In general, the more negative the  $\Delta W/A$  value at any given time, the poorer the cycle oxidation resistance.

Variability of the data is also a consideration in cyclic oxidation testing. This was discussed previously for this type of test in reference 11.

Large differences in specific-weight-change values for a given alloy for replicate test samples correlate with the variations of oxide(s) detected by x-ray diffraction. These effects have been discussed in detail in references 6, 9, 10, and 12. In the x-ray diffraction results under the designation "spinel,"  $a_0$  values of 8.05 to 8.15 Å refer to aluminate spinel, whereas  $a_0$  values of 8.20 to 8.35 Å denote chromite spinel.

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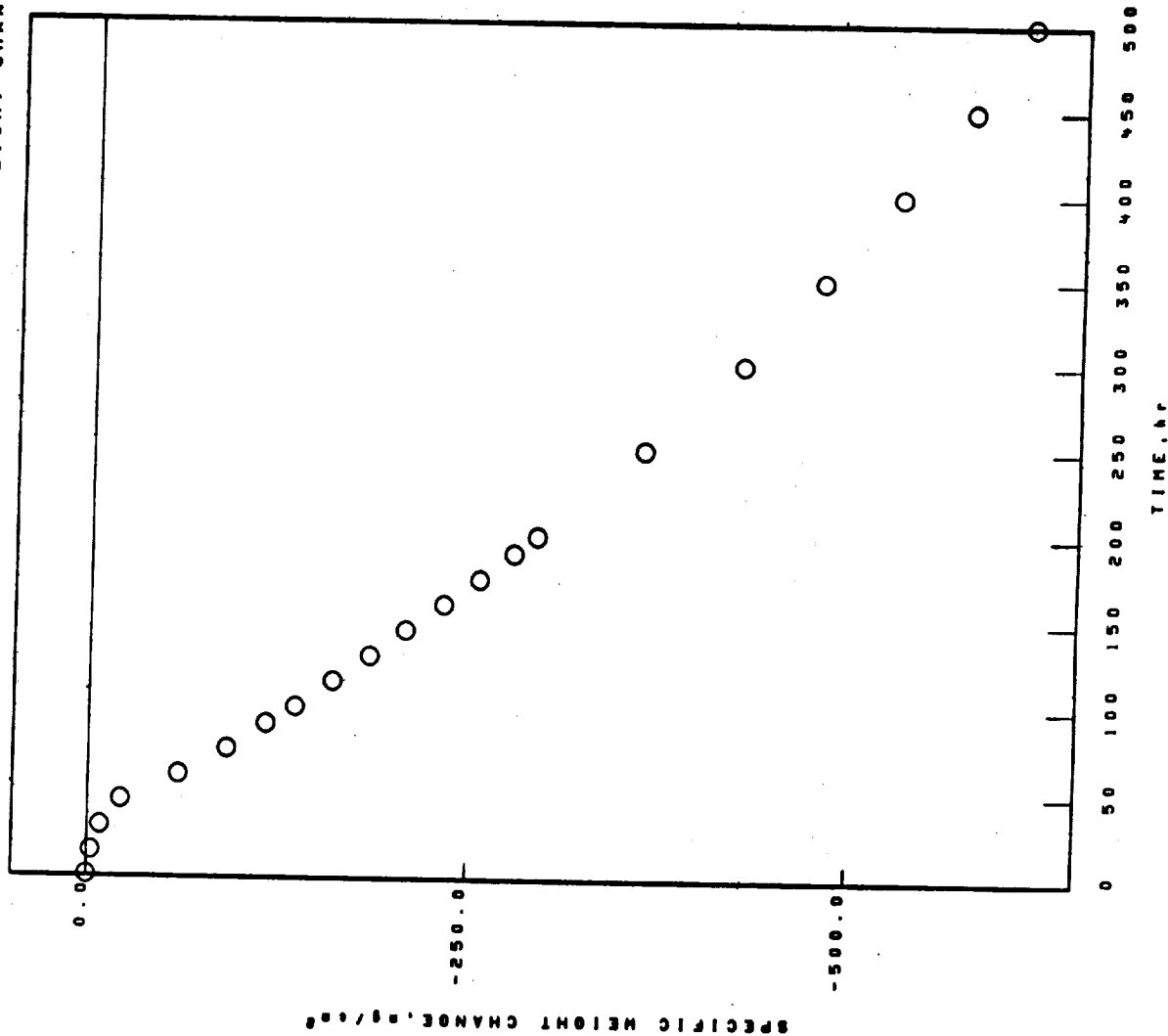
TABLE I.—NOMINAL ALLOY COMPOSITION FOR HIGH-TEMPERATURE TURBINE ALLOYS

Alloy	Composition, wt %												Comments	
	Ni	Co	Cr	Al	Ti	Mo	W	Cb	Ta	C	B	Zr		Hf
Alloy 625	Balance	---	22.5	0.2	0.2	9.0	---	See Comments	See Comments	0.05	---	---	---	Cb + Ta = 3.65 With 18.5 wt % Fe; Cb + Ta = 5.30 Similar to U-700 <sup>a4</sup>
Alloy 718	---	---	19.0	.5	.9	3.05	---	See Comments	See Comments	.04	0.005	---	---	
Astrolloy	---	15.0	15.0	4.4	3.5	5.25	4.0	---	---	.06	.03	0.06	---	
B-1900	10.0	8.0	8.0	6.0	1.0	6.0	.1	0.1	4.3	.1	.015	.08	---	
B-1900 + Hf	10.0	8.0	8.0	6.0	1.0	6.0	.1	.1	4.3	.1	.015	.08	1.0	With 1.0 wt % V; <sup>a3</sup> <sup>a4</sup> <sup>a6</sup> ; includes one hot-worked alloy with ~0 Cb <sup>a4</sup>
IN-100	15.0	10.0	10.0	5.5	5.5	3.0	---	---	---	.18	.015	.05	---	
IN-713LC	---	---	12.0	5.9	.6	4.5	---	2.0	---	.05	.010	.10	---	
IN-738	8.5	---	16.0	3.4	3.4	1.75	2.6	.9	1.75	.17	.010	.10	---	
IN-792	---	9.0	12.7	3.2	4.2	2.0	3.9	---	3.9	.21	.02	.10	.75	<sup>a2</sup>
IN-939	---	19.0	22.0	2.0	3.6	---	2.0	1.0	1.5	.15	.01	.10	---	
MAR-M-200	---	10.0	9.0	5.0	2.0	---	12.5	2.7	---	.15	.015	.05	---	
MAR-M-200 + Hf	---	10.0	9.0	5.0	2.0	---	11.5	1.0	---	.15	.015	.05	1.5	
MAR-M-211	10.0	10.0	9.0	5.0	2.0	2.5	5.0	2.7	---	.15	.015	.05	---	With 0.1 wt % Cu <sup>a2</sup> <sup>a2</sup> With 0.5 wt % Re <sup>b</sup> ; <sup>a3</sup>
MAR-M-246	11	---	11	5.0	1.5	---	---	---	2.0	.09	.01	.01	---	
MAR-M-247	10.0	10.0	8.2	5.5	1.0	.6	10.0	---	3.0	.16	.02	.09	1.5	
MAR-M-421	9.5	---	15.8	4.3	1.8	2.0	3.8	2.0	---	.15	.015	.05	---	
NASA-TRW-VIA	7.5	---	6.1	5.4	1.0	2.0	5.8	.5	9.0	.13	.02	.13	.40	<sup>a4</sup> With 3.0 wt % Re and 2.2 wt % V <sup>a2</sup>
Nimonic 115	14.0	---	14.6	4.9	4.0	3.5	---	---	---	.16	.015	.001	---	
NX-188	---	---	<10	8.0	---	18.0	---	---	---	.04	---	---	---	
René 41	11.0	---	19.0	1.5	3.1	10.0	---	---	---	.09	.01	---	---	
René 80	9.5	---	14.0	3.0	5.0	4.0	---	---	---	.17	.015	.03	---	<sup>a7</sup> ; includes three bar stock alloys; varying Co levels <sup>c</sup>
René 120	10.0	---	9.0	4.3	4.0	2.0	7.0	---	3.8	---	.015	.07	---	
René 125	10.0	---	9.0	5.0	2.5	2.0	7.0	---	3.8	.10	.02	.05	1.50	
R-150-SX	12.0	---	5.0	5.5	---	1.0	5.0	---	6.0	---	---	---	---	
TAZ-8A	---	---	6.0	6.0	---	4.0	4.0	2.5	8.0	.125	.004	1.0	---	With 2.0 wt % Fe
TRW-R	---	8.0	8.0	5.3	.8	3.0	4.0	.3	6.0	.05	.015	.12	1.00	
TRW-1800	---	.6	13.0	6.0	.6	---	9.0	1.5	---	.09	.07	.07	---	
U-520	12.0	---	19.0	2.0	3.0	6.0	1.0	---	---	.05	.005	---	---	
U-700	18.5	---	15.0	4.3	3.5	4.5	---	---	---	.07	.03	.08	---	With 2.0 wt % Fe
U-710	---	15.0	18.0	2.5	5.0	3.0	1.5	---	---	.10	.012	---	---	
U-720	---	15.0	18.0	2.5	5.0	3.0	1.2	---	---	.04	.03	.03	---	
Waspaloy	---	13.5	19.5	1.3	3.0	4.3	---	---	---	.08	.006	.06	---	
WAZ-20	---	---	---	6.5	---	18.5	---	---	---	.15	---	.15	---	With 2.0 wt % Fe
MAR-M-509	10.0	Balance	23.5	---	.2	---	7.0	2.0	3.5	.60	---	.50	---	
WT-52	---	Balance	21.0	---	---	---	11.0	---	---	.45	---	---	---	
X-40	10.5	Balance	25.5	---	---	---	7.5	---	---	.50	---	---	---	

<sup>a</sup>Represents number of vendors and/or different heats tested.<sup>b</sup>A modified form of VIA was tested where 0.5 Re was replaced with an additional 0.5 Hf.<sup>c</sup>U-700 alloys had Co levels of 14.5 to 19.0 wt %.

NI BASE  
 ALLOY 625  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 500.00hr TEST 2.313mm THICK STATIC AIR  
 02-13-001-351-4

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-001-351-4  
 ALLOY 625 1100°C 1.00hr CYCLES 500.00hr TEST 2.313mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -0.30A.  
 NiO  
 TRI(RUTILE).4(110)>3.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

SPALL  
 200 hr  
 COLLECTED SPALL  
 SPINEL.  $\theta$ -0.30A.  
 NiO  
 TRI(RUTILE).4(110)>3.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

500 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -0.35A.  
 NiO  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)>3.30A.

500 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -0.30A.  
 TRI(RUTILE).4(110)>3.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

NI BASE

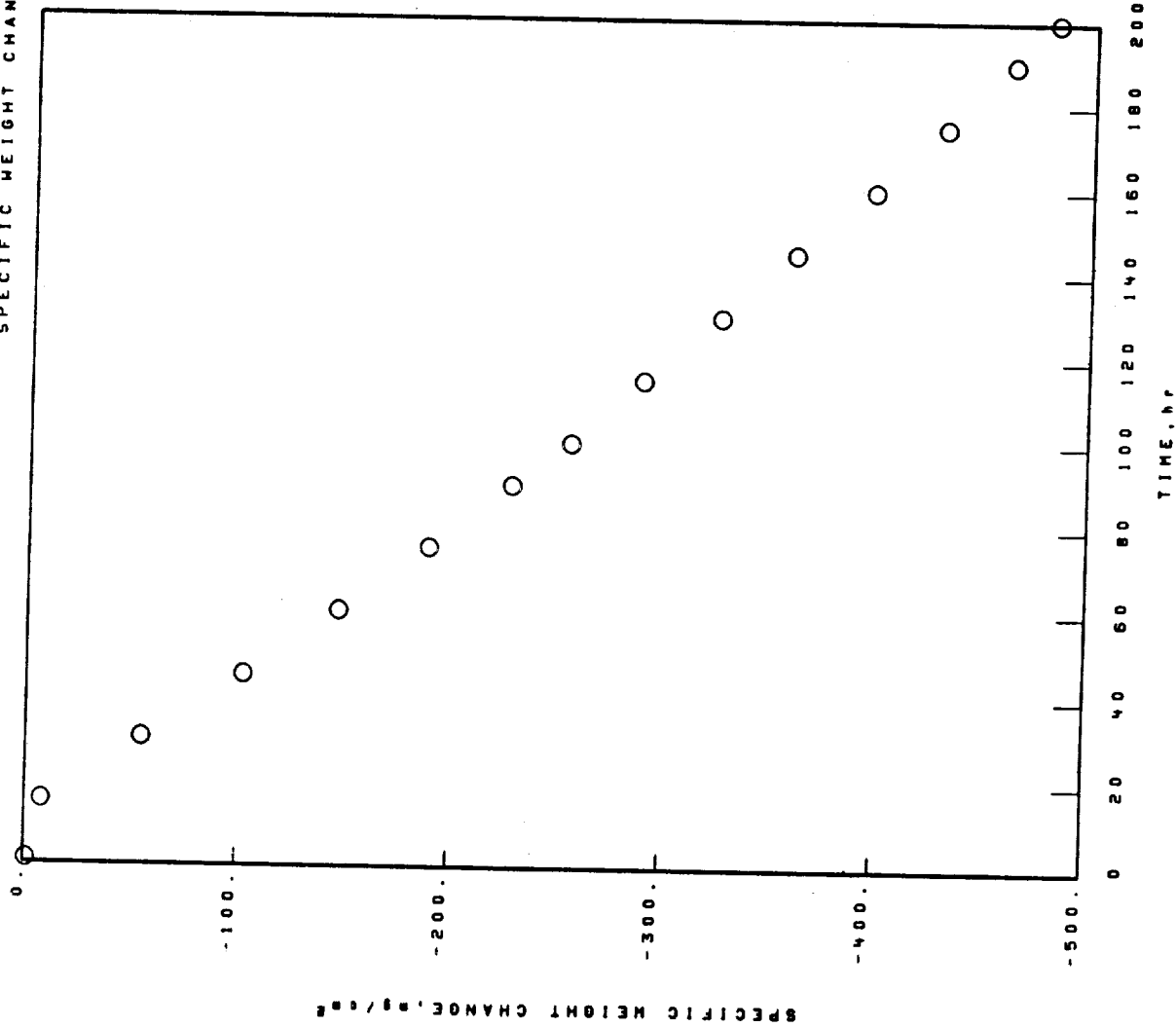
COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

ALLOY 718

02-13-002-352-3

1150°C 1.00hr CYCLES 200.00hr TEST 2.328mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔM/A, g/cm²
0.00	0.00
1.00	-1.11
15.00	-7.99
30.00	-54.69
45.00	-102.44
60.00	-147.34
75.00	-189.36
90.00	-228.16
100.00	-255.74
115.00	-289.40
130.00	-325.61
145.00	-360.26
160.00	-397.07
175.00	-430.38
190.00	-461.90
200.00	-482.05

## MI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

CYCLES

1150°C

ALLOY 718

200.00hr

## X-RAY DIFFRACTION DATA

## SURFACE

200 hr

## STANDARD SURFACE

NIO

SPINEL.  $\theta_0 = 8.30^\circ$ Cr<sub>2</sub>O<sub>3</sub>TRI(RUTILE).  $\theta(110) \leq 3.30^\circ$ 

## SPALL

200 hr

## COLLECTED SPALL

SPINEL.  $\theta_0 = 8.30^\circ$ 

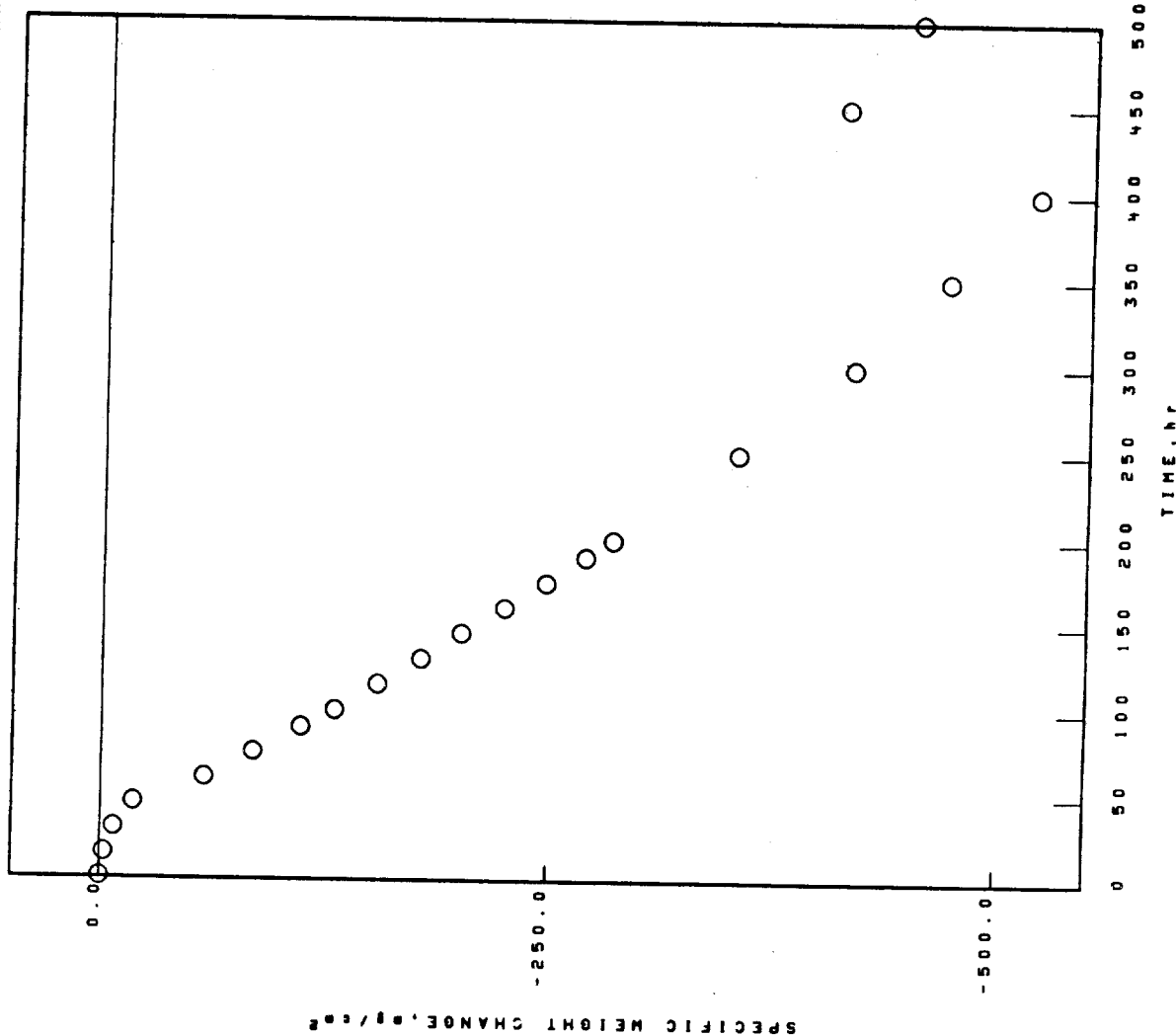
NIO

Cr<sub>2</sub>O<sub>3</sub>TRI(RUTILE).  $\theta(110) > 3.3^\circ$ 

## FACE CENTERED CUBIC MATRIX

NI BASE  
 ALLOY 718  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 500.00hr TEST 2.320mm THICK STATIC AIR  
 02-13-002-351-3

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS                      02-13-002-351-3  
 ALLOY 718                      1100°C                      1.00hr CYCLES                      500.00hr TEST                      2.320mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta_0=8.30A$ .	SPINEL. $\theta_0=8.30A$ .
NiO	NiO
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
TRI(RUTILE).4(110)>3.30A.	TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

500 hr	500 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta_0=8.35A$ .	SPINEL. $\theta_0=8.30A$ .
NiO	NiO
Cr <sub>2</sub> O <sub>3</sub>	TRI(RUTILE).4(110)>3.30A.
TRI(RUTILE).4(110)>3.30A.	Cr <sub>2</sub> O <sub>3</sub>

FACE CENTERED CUBIC MATRIX

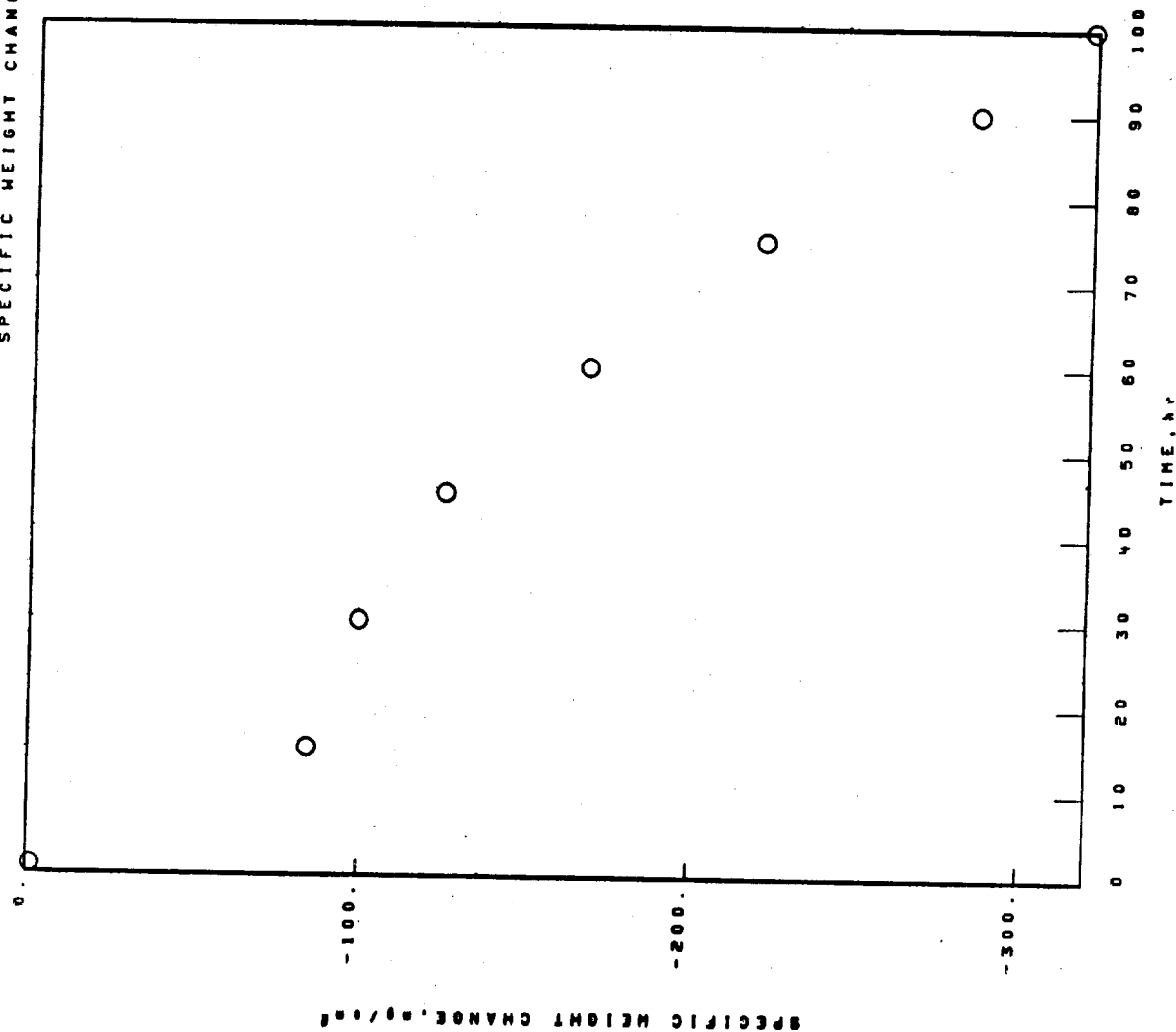
NI BASE  
ASTROLOY

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-003-472-3

1150°C 1.00hr CYCLES 100.00hr TEST 2.30P - THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
-1.30  
-84.36  
-99.50  
-125.30  
-160.23  
-220.52  
-284.96  
-310.03



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
ASTROLOY 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

SURFACE  
1 hr  
STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)S3.30A.  
TRI(RUTILE).4(110)S3.30A.  
SPINEL. #0-8.05A.

UNKNOWN LINES. 4 VALUES  
3.45A.  
3.47A.

## FACE CENTERED CUBIC MATRIX

100 hr  
STANDARD SURFACE  
SPINEL. #0-8.30A.  
(Ni.Cr)O  
Cr<sub>2</sub>O<sub>3</sub>  
Ni(W.M.)O, TYPE 2

## FACE CENTERED CUBIC MATRIX

100 hr  
COLLECTED SPALL  
NiO  
SPINEL. #0-8.30A

## SPALL

1 hr  
COLLECTED SPALL  
Cr<sub>2</sub>O<sub>3</sub>  
NiO  
TRI(RUTILE).4(110)S3.30A.

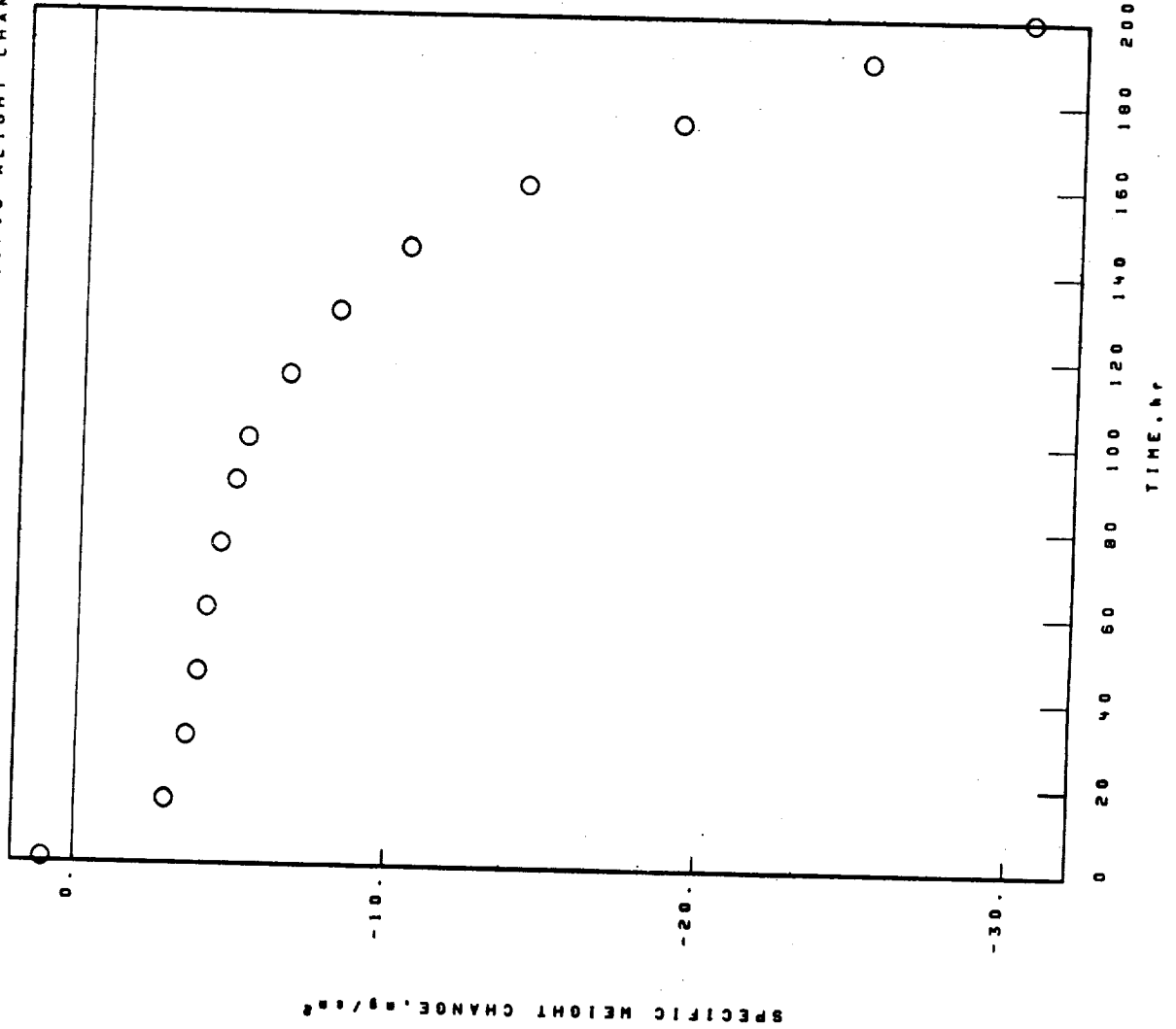
NI BASE  
ASTROLOY

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-003-473-3

1100°C 1.00hr CYCLES 200.00hr TEST 2.301mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	1.00
15.00	-2.90
30.00	-3.55
45.00	-3.88
60.00	-4.12
75.00	-4.52
90.00	-4.97
100.00	-5.31
115.00	-6.61
130.00	-8.17
145.00	-10.38
160.00	-14.13
175.00	-19.04
190.00	-25.08
200.00	-30.25

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
ASTROLOY 1100°C 1.00hr CYCLES 200.00hr TEST 2.301hr THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE). 00-0-25A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

NiO

SPINEL. 00-0-10A.

SPINEL. 00-0-25A.

(Ni<sub>1</sub>Co<sub>1</sub>Fe<sub>1</sub>)TiO<sub>3</sub>Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

(Ni<sub>1</sub>Co<sub>1</sub>Fe<sub>1</sub>)TiO<sub>3</sub>Cr<sub>2</sub>O<sub>3</sub>Al<sub>2</sub>O<sub>3</sub>

NiO

SPINEL. 00-0-25A.

TRI(RUTILE). 00-0-25A.

SPINEL. 00-0-10A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 00-0-30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 00-0-10A.

200 hr

## COLLECTED SPALL

NiO

SPINEL. 00-0-25A.

NI BASE

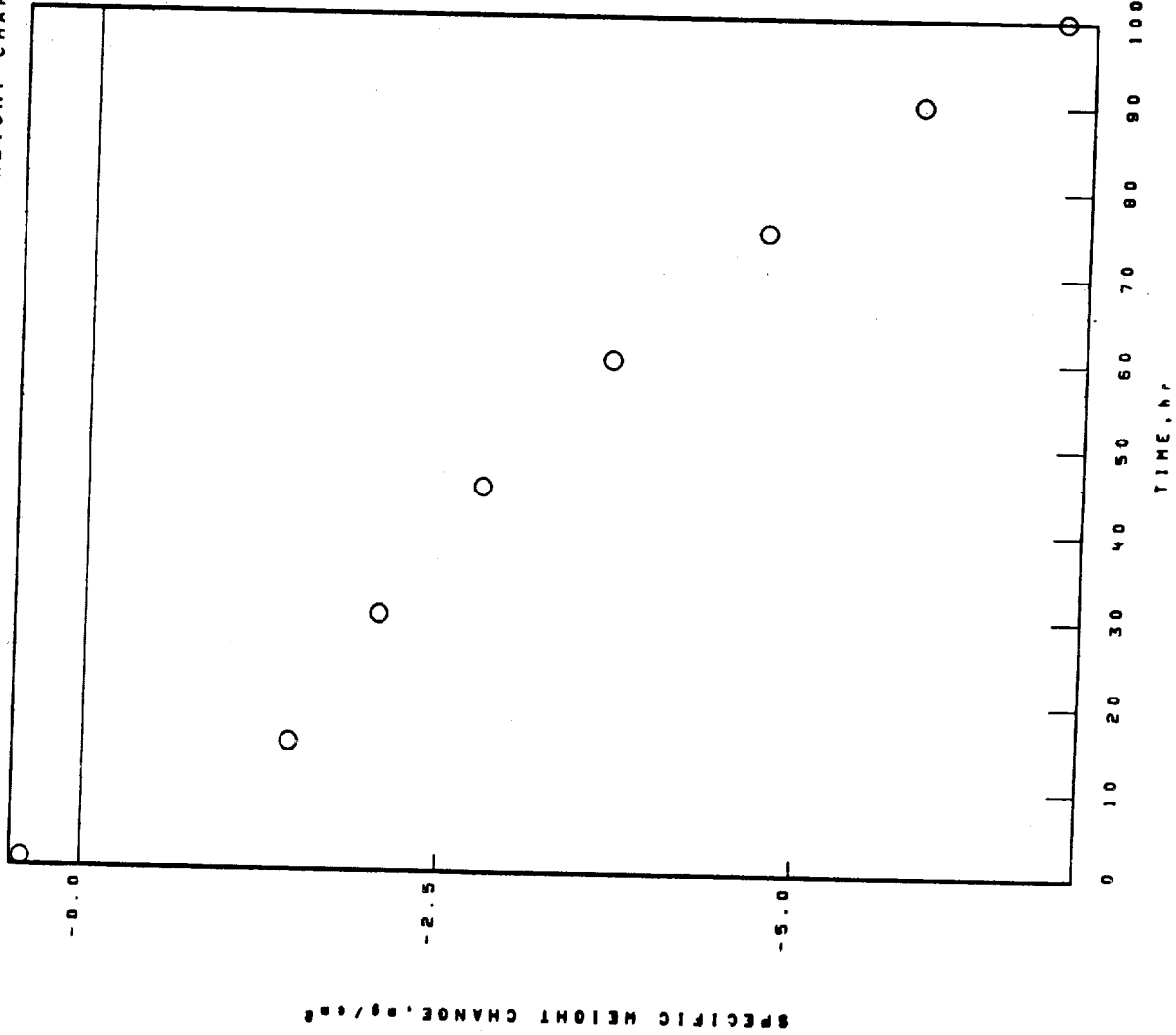
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

B-1900

02-04-001-107-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.741in THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.42
15.00	-1.45
30.00	-2.06
45.00	-2.77
60.00	-3.67
75.00	-4.73
90.00	-5.80
100.00	-6.80

02-04-001-107-5

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.710mm

TEST 100.00hr

1.00hr CYCLES

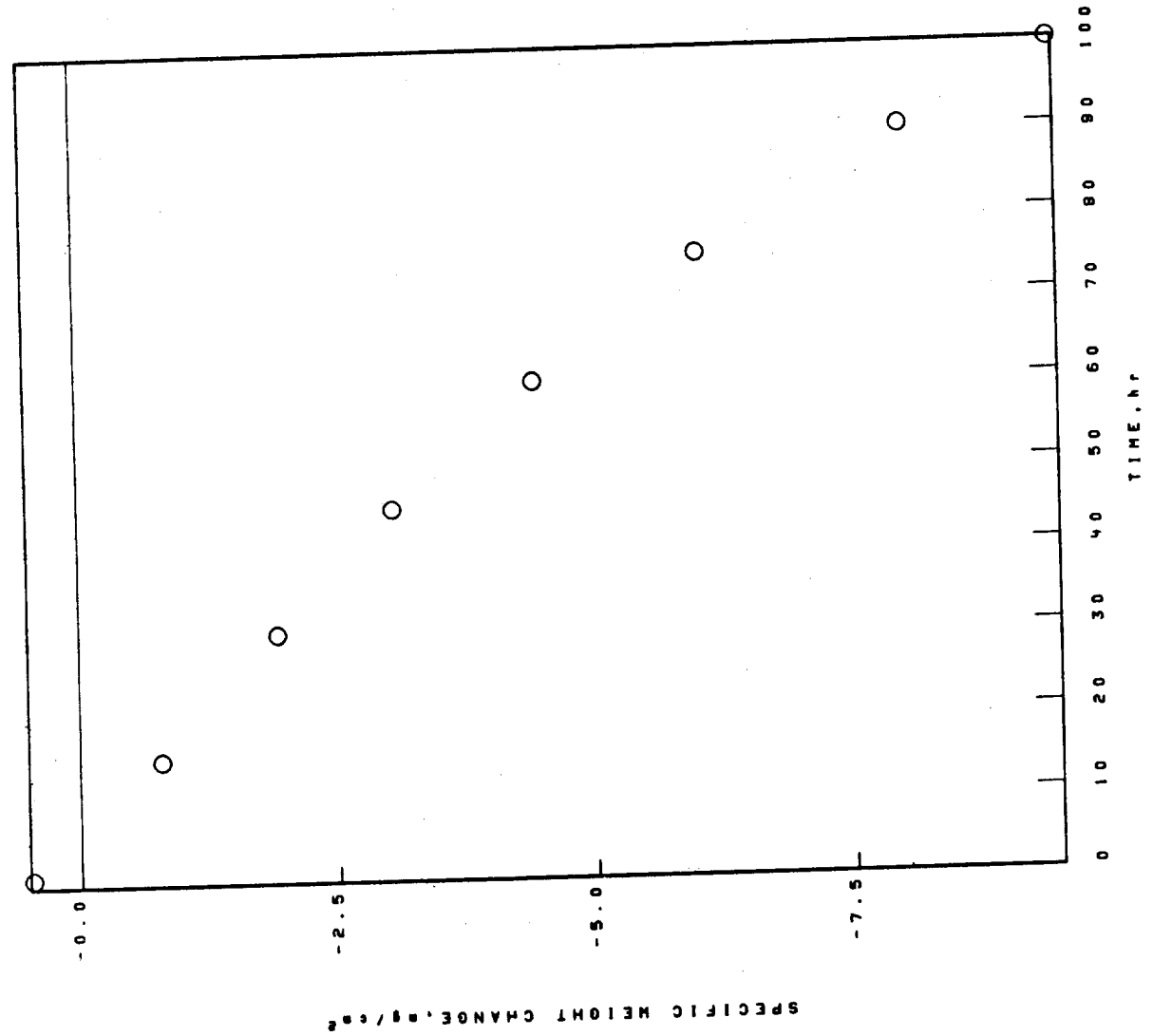
1150°C

M1 BASE

B-1900

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.47
15.00	-0.79
30.00	-1.92
45.00	-3.06
60.00	-4.43
75.00	-6.03
90.00	-8.00
100.00	-9.45



NI BASE  
 B-1900  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.710mm THICK STATIC AIR  
 02-04-001-107-5

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
TR (RUTILE), 4(110) 53.30A.	NIO
Al <sub>2</sub> O <sub>3</sub>	TRI (RUTILE), 4(110) 53.30A.
SPINEL, 2θ=8.15A.	TRI (RUTILE), 4(110) 53.30A.
NIO	SPINEL, 2θ=8.10A.

FACE CENTERED CUBIC MATRIX

02-04-001-321-2

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1150°C 1.00hr CYCLES 100.00hr TEST 2.334 THICK STATIC AIR

THICK

TEST

2.334

THICK

STATIC AIR

THICK

TEST

2.334

THICK

STATIC AIR

THICK

TEST

2.334

THICK

STATIC AIR

THICK

TEST

0.00

0.38

-0.92

-1.98

-2.96

-3.68

-4.42

-5.02

-5.50

0.00

0.38

-0.92

-1.98

-2.96

-3.68

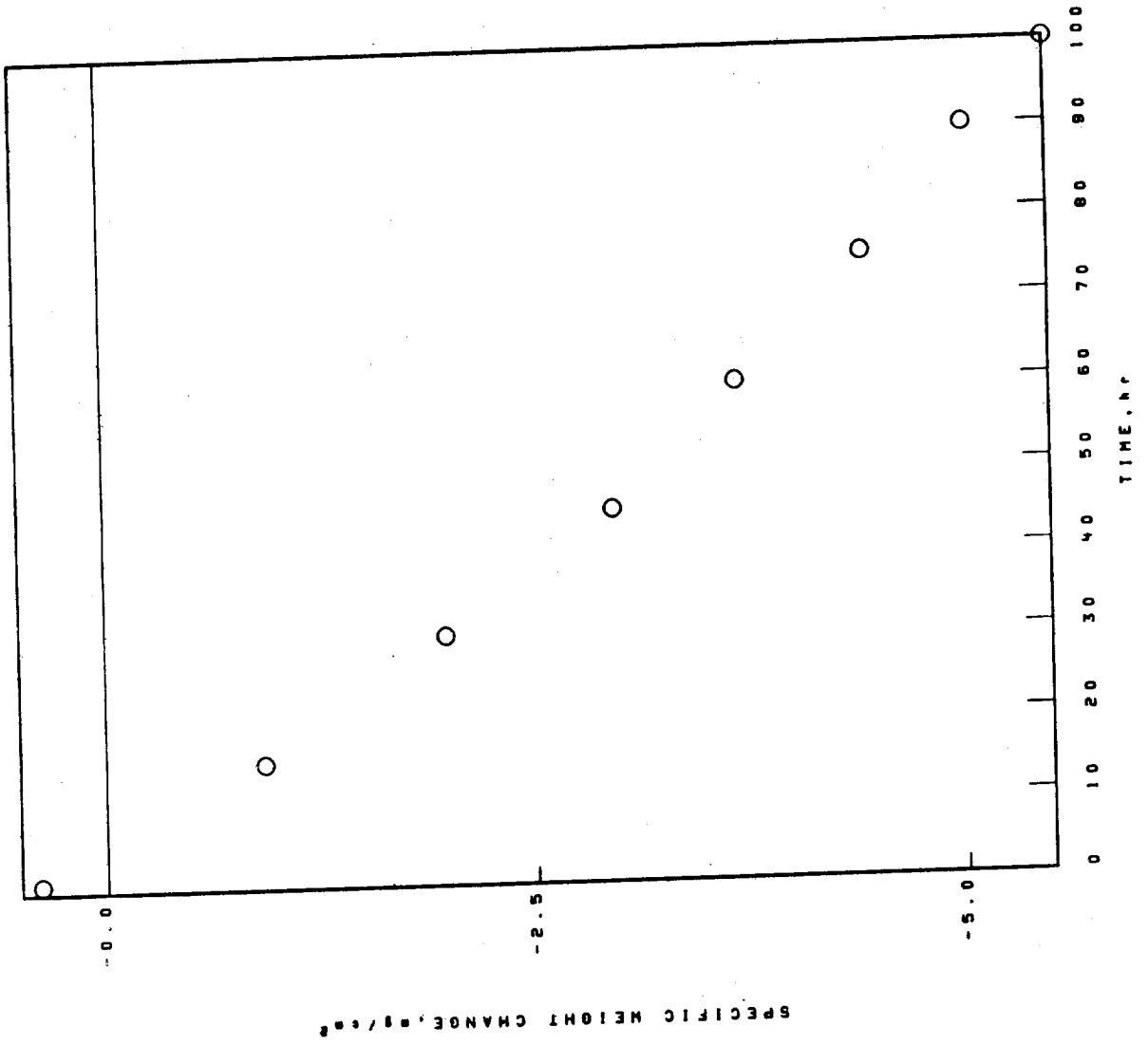
-4.42

-5.02

-5.50

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.38
15.00	-0.92
30.00	-1.98
45.00	-2.96
60.00	-3.68
75.00	-4.42
90.00	-5.02
100.00	-5.50



N1 BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-001-321-2

8-1900

1150°C 1.00hr CYCLES 100.00hr TEST 2.334mm THICK STATIC AIR

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $\theta_0$ -8.25A.

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.25A.

SPINEL.  $\theta_0$ -8.05A.

TRI(RUTILE).4(110)13.30A.

TRI(RUTILE).4(110)13.30A.

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

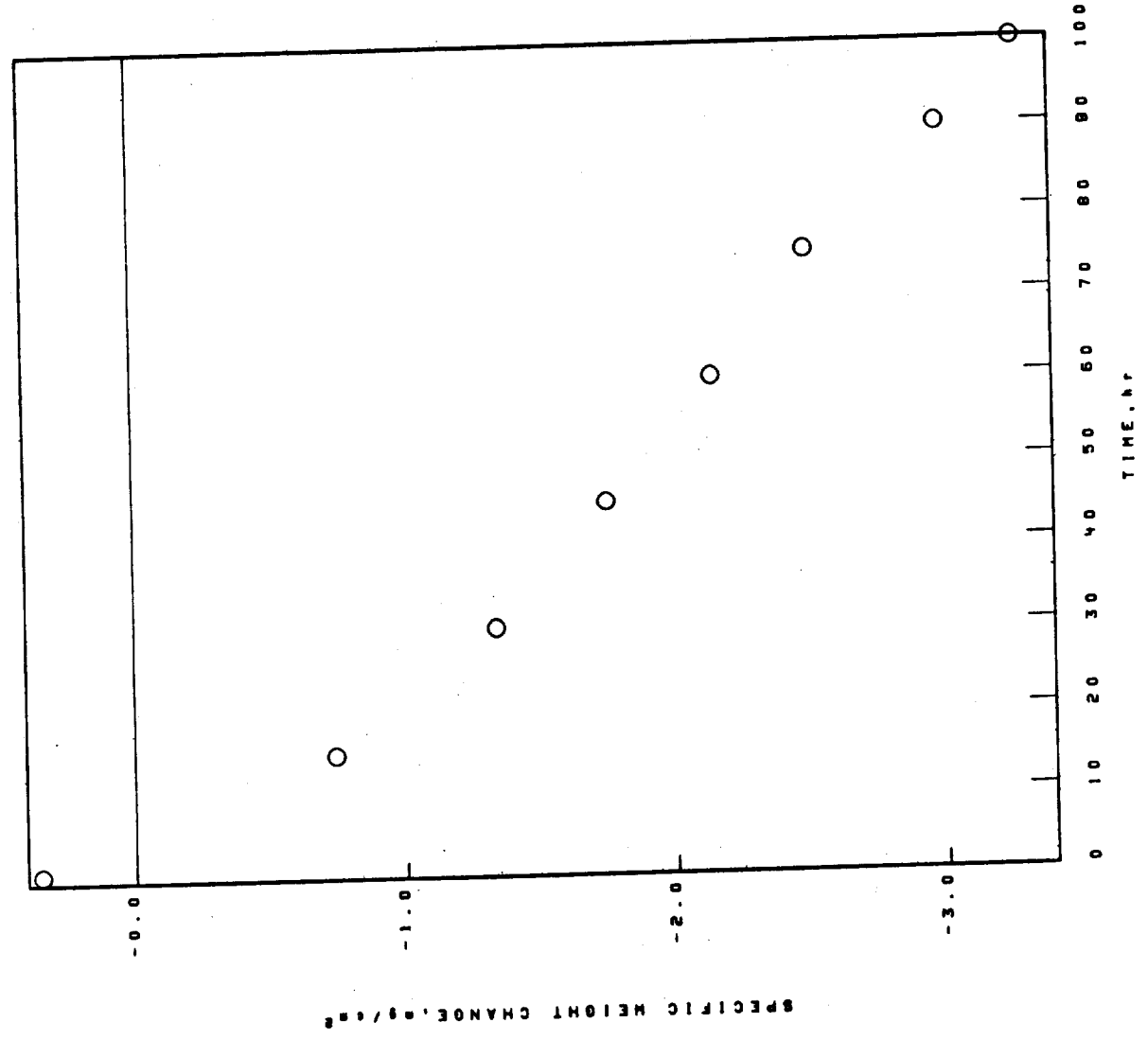
X-RAY DIFFRACTION DATA



NI BASE  
 B-1900  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150 °C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR(SMP)  
 02-04-001-328-1

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, g/cm^2$
0.00	0.00
0.35	0.35
1.00	-0.74
15.00	-1.34
30.00	-1.75
45.00	-2.15
60.00	-2.48
75.00	-2.98
90.00	-3.27
100.00	



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

B-1900

02-04-001-328-1

1150°C

1.00hr CYCLES

100.00hr TEST

2.318mm THICK

STATIC AIR(SHA

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0 = 8.10A$ .

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).  $\theta_0 = 11.0$  13.30A.

SPINEL.  $\theta_0 = 8.25A$ .

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

PROBABLE CROSS-SPALL

NI<sub>2</sub>

SPINEL.  $\theta_0 = 8.30A$ .

Cr<sub>2</sub>O<sub>3</sub>

CoO

TRI(RUTILE).  $\theta_0 = 11.0$  13.30A.

02-04-001-337-4

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

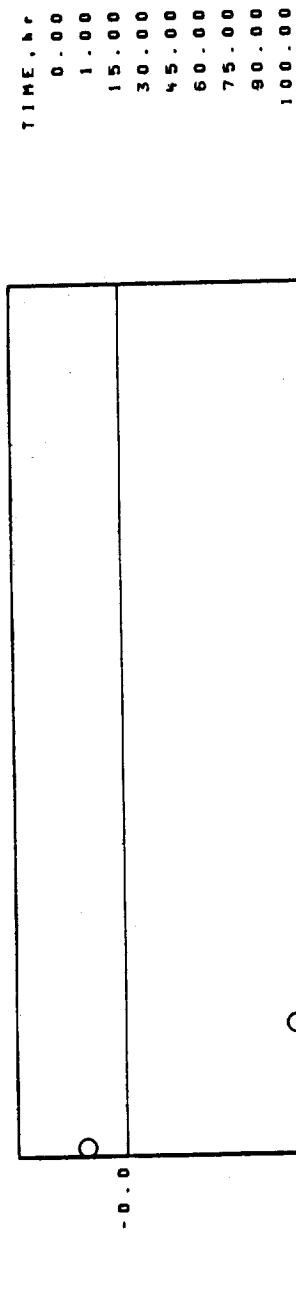
N1 BASE

STATIC AIR

B-1900

1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 8-1800  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR  
 02-04-001-337-4

X-RAY DIFFRACTION DATA

SURFACE

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0$ -8.10A.  
 $Al_2O_3$   
 TRI(RUTILE).  $\theta_0$ (110)53.30A.  
 SPINEL.  $\theta_0$ -8.25A.

FACE CENTERED CUBIC MATRIX

SPALL

100 hr  
 COLLECTED SPALL  
 $NiO$   
 SPINEL.  $\theta_0$ -8.30A.  
 TRI(RUTILE).  $\theta_0$ (110)53.30A.  
 SPINEL.  $\theta_0$ -8.10A.  
 $Ni(Mn)O$ , TYPE I  
 $Cr_2O_3$   
 $Al_2O_3$

02-04-001-327-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

N1 BASE

STATIC AIR SMP

1100°C

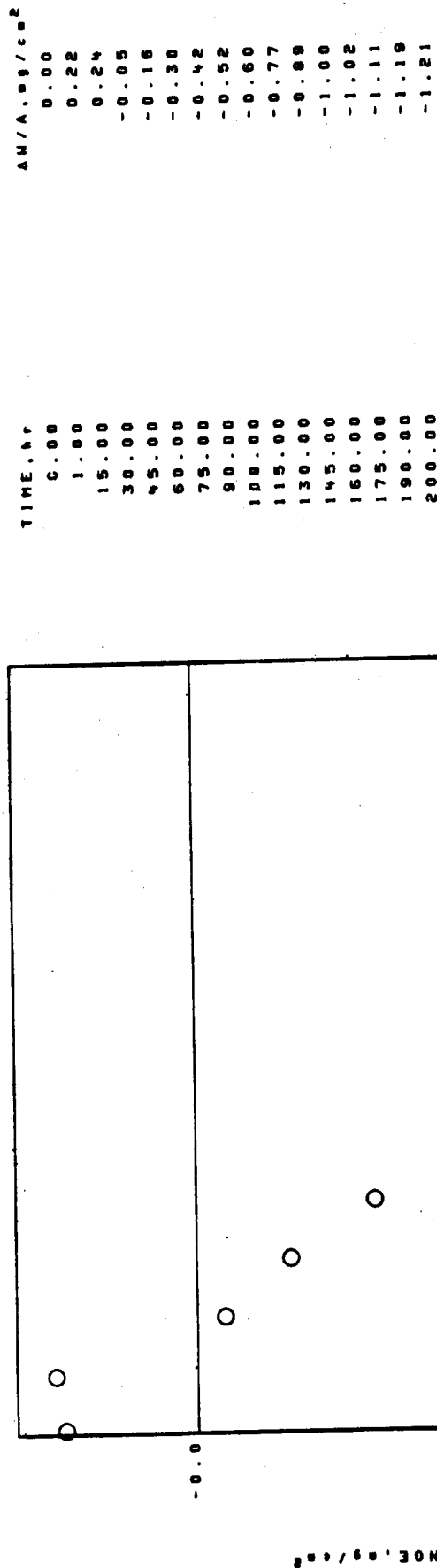
1.00hr CYCLES

200.00hr TEST

2.340mm THICK

8-1900

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-001-327-1

B-1900

1100°C 1.00hr CYCLES 200.00hr TEST 2.340mm THICK STATIC AIR SMP

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

SPINEL,  $\theta_0 = 8.05^\circ$

FACE CENTERED CUBIC MATRIX

SPALL

200 hr

PROBABLE CROSS-SPALL

SPINEL,  $\theta_0 = 8.30^\circ$

CaO

TRI(RUTILE),  $\theta_0(110) = 3.30^\circ$

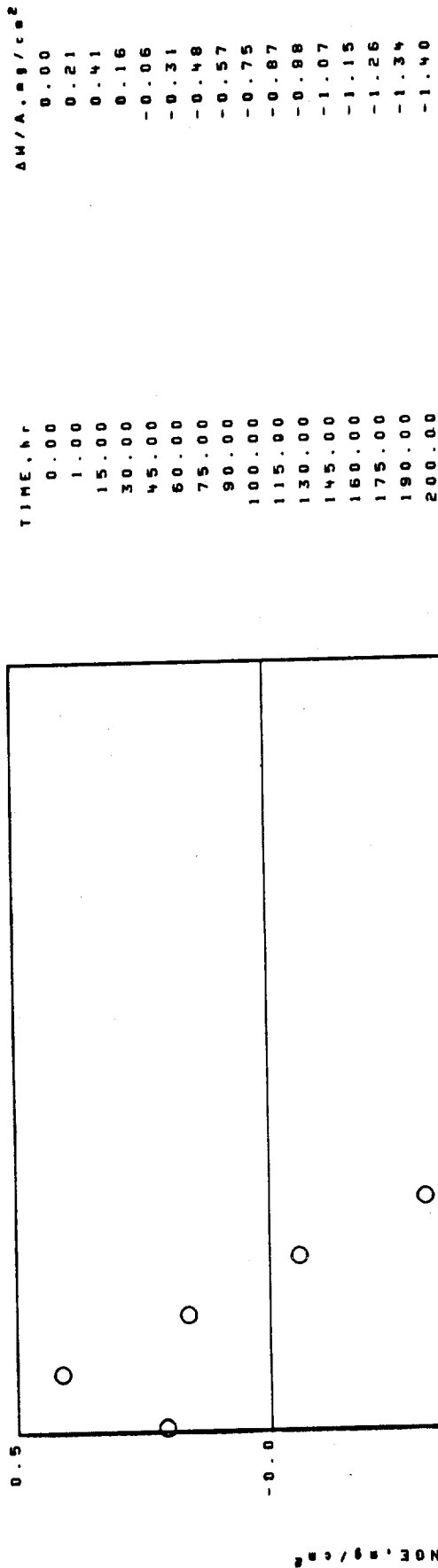
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

N1 BASE

B-1900

1100°C 1.00hr CYCLES 200.00hr TEST 2.333mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 8-1900  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.333mm THICK  
 STATIC AIR  
 02-04-001-324-2

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 SPINEL,  $\theta$ -8.10A.  
 $Al_2O_3$   
 TRI(RUTILE),  $\theta$ (110)13.30A.  
 FACE CENTERED CUBIC MATRIX

SPALL  
 200 hr  
 COLLECTED SPALL  
 NiO  
 TRI(RUTILE),  $\theta$ (110)13.30A.  
 SPINEL,  $\theta$ -8.25A.  
 SPINEL,  $\theta$ -8.10A.

UNKNOWN LINES.  $\theta$  VALUES  
 3.10A.  
 3.69A.  
 3.57A.

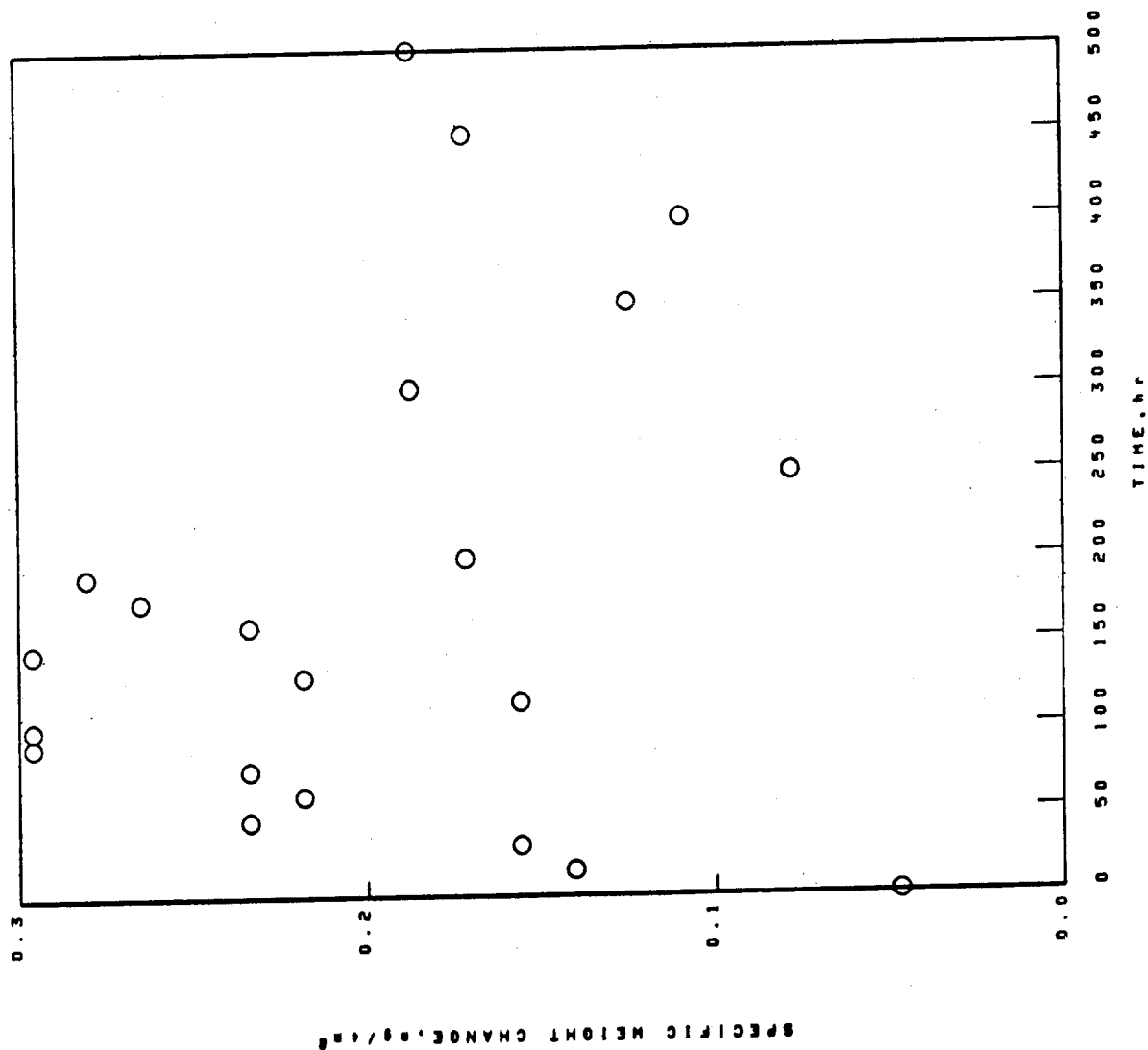


NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1000°C 1.00hr CYCLES 500.00hr TEST 2.330 THICK STATIC AIR

8-1900

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-471-3  
 B-1800 1000°C 1.00hr CYCLES 500.00hr TEST 2.330mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.10A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)13.30A.

ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

500 hr

500 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

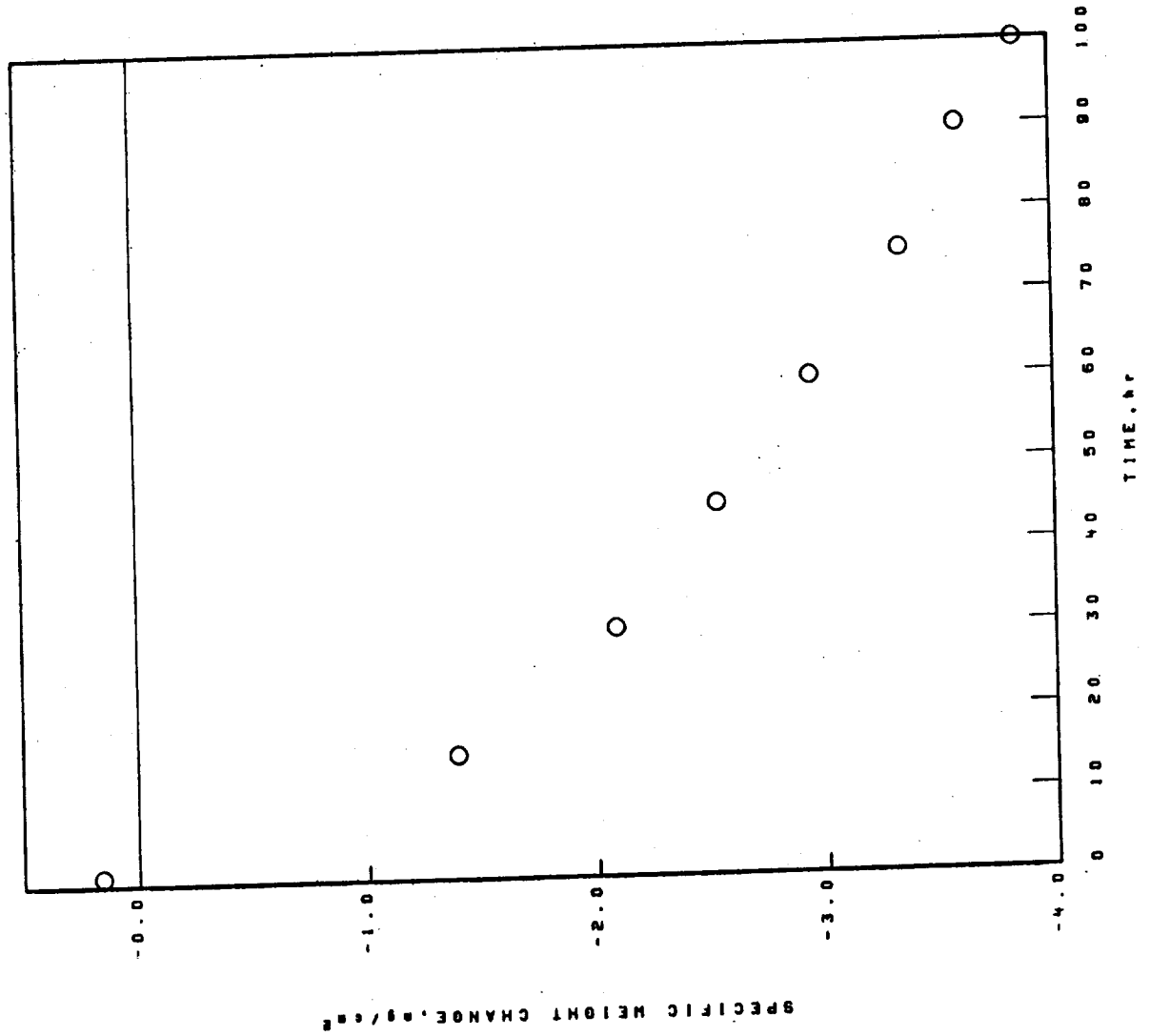
STATIC AIR

1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK

B-1900-H7

## SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{g}/\text{cm}^2$
0.00	0.00
1.00	0.16
15.00	-1.39
30.00	-2.09
45.00	-2.53
60.00	-2.94
75.00	-3.34
90.00	-3.59
100.00	-3.65



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-002-323-3

B-1900-HY

1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL,  $\theta_0$ -8.10A.

HfO<sub>2</sub>

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

PROBABLE CROSS-SPALL

NiO

SPINEL,  $\theta_0$ -8.30A.

TRI(RUTILE).4(110)53.30A.

Ni(W.M.)O<sub>4</sub> TYPE 1

C<sub>2</sub>O

02-04-002-474-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

B-1900+Mf

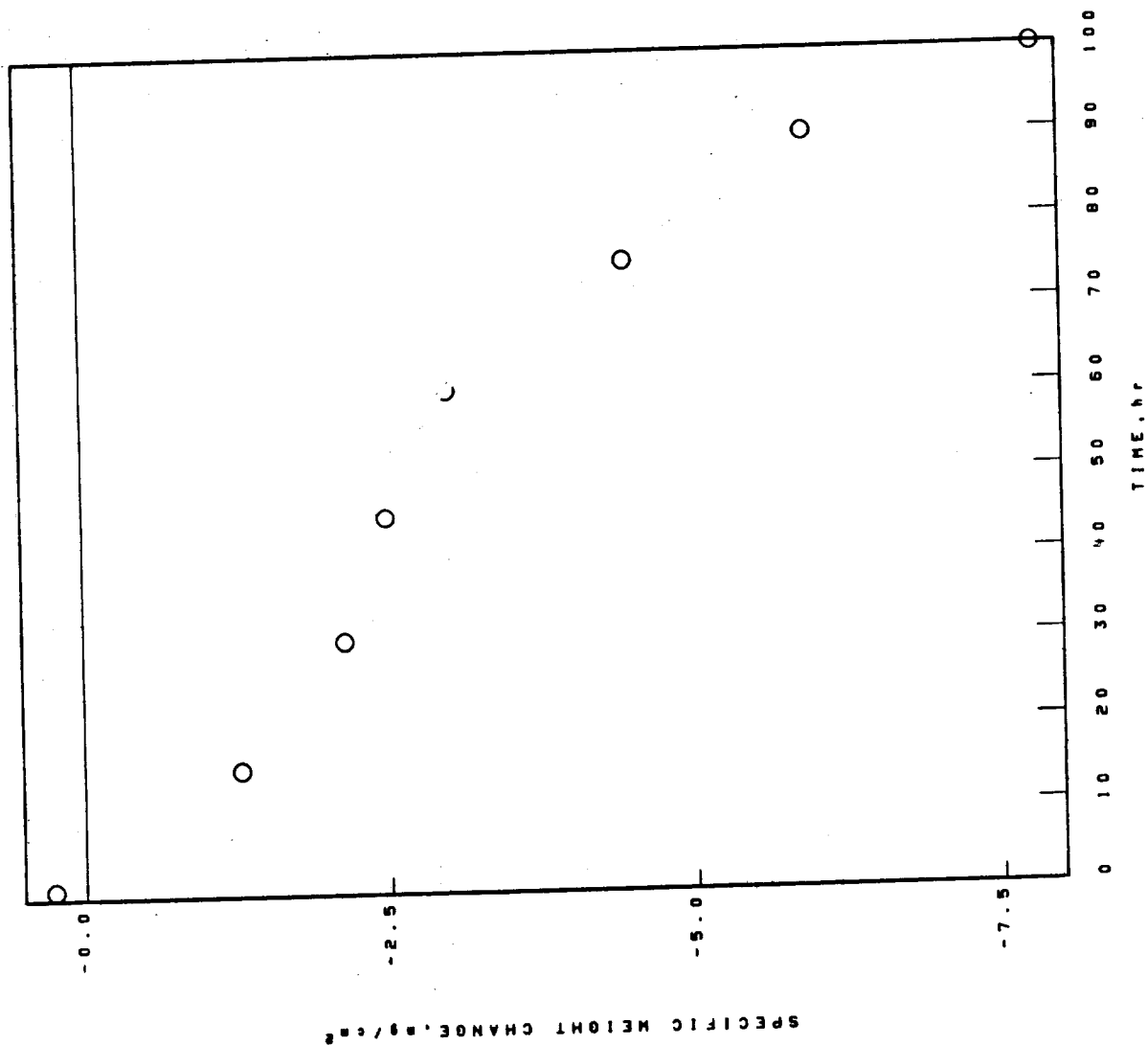
STATIC AIR

THICK 2.308mm

1150°C 1:00hr CYCLES 100.00hr TEST

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.25
15.00	-1.28
30.00	-2.14
45.00	-2.49
60.00	-3.00
75.00	-4.45
90.00	-5.93
100.00	-7.80



# NI BASE B-1900+Hf COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1150°C 1.00hr CYCLES 100.00hr TEST 2.308mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

### SURFACE

1 hr

### STANDARD SURFACE

SPINEL,  $a_0=8.25\text{\AA}$ .

SPINEL,  $a_0=8.10\text{\AA}$ .

TRI(RUTILE),  $d(110)13.30\text{\AA}$ .

Al<sub>2</sub>O<sub>3</sub>

HfO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

### FACE CENTERED CUBIC MATRIX

100 hr

### STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

HfO<sub>2</sub>

SPINEL,  $a_0=8.10\text{\AA}$ .

TRI(RUTILE),  $d(110)13.30\text{\AA}$ .

### FACE CENTERED CUBIC MATRIX

### SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

### COLLECTED SPALL

NiO

TRI(RUTILE),  $d(110)13.30\text{\AA}$ .

SPINEL,  $a_0=8.10\text{\AA}$ .

SPINEL,  $a_0=8.25\text{\AA}$ .

Cr<sub>2</sub>O<sub>3</sub>

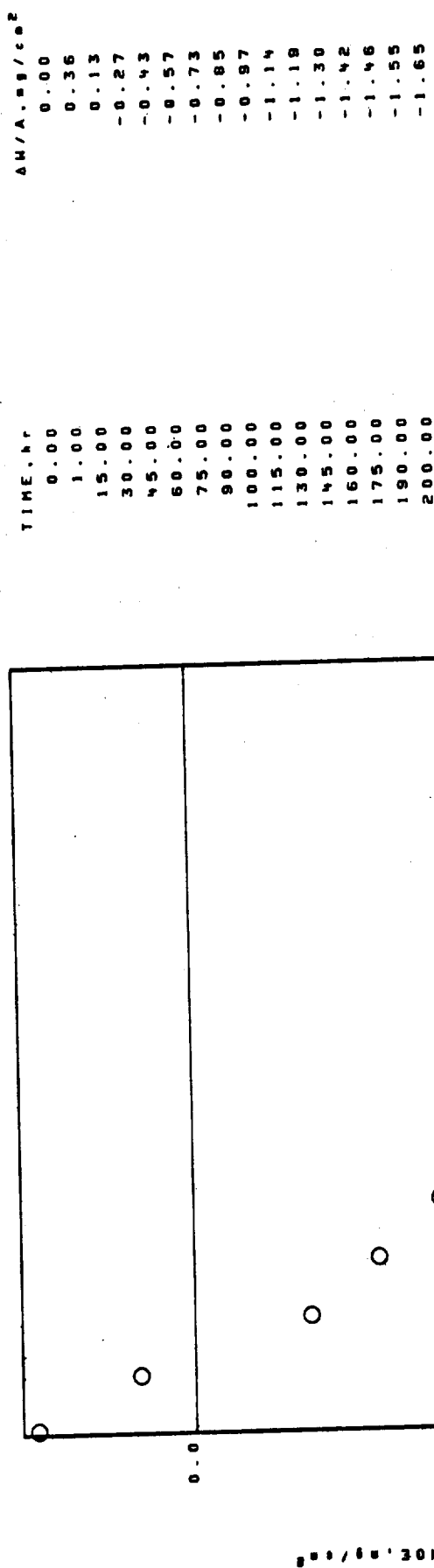
## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

B-1900-MF

1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

## SPECIFIC HEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

B-1900+H1

02-04-002-326-3

1100°C

1.00hr CYCLES 200.00hr TEST 2.330mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

SPINEL,  $\theta_0 = 8.05^\circ$

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE),  $4(110) \Delta 3.30^\circ$

HfO<sub>2</sub>

SPALL

200 hr

PROBABLE CROSS-SPALL

SPINEL,  $\theta_0 = 8.35^\circ$

CaO

Al<sub>2</sub>TiO<sub>5</sub>

TRI(RUTILE),  $4(110) \Delta 3.30^\circ$

FACE CENTERED CUBIC MATRIX



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

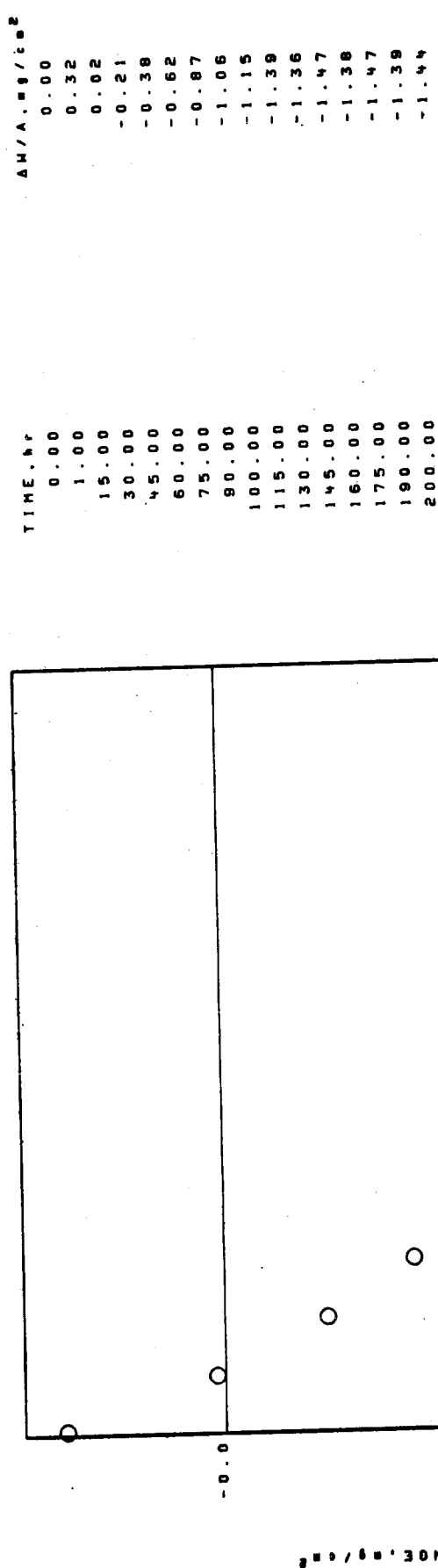
NI BASE

STATIC AIR

1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK

B-1900-Hr

## SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-002-475-1  
 8-1900-Hr                      1100°C      1-00hr CYCLES      200.00hr TEST      2.315mm THICK      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.25A.

HfO<sub>2</sub>

SPINEL. 00-8.10A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 00-8.10A.

Al<sub>2</sub>O<sub>3</sub>

HfO<sub>2</sub>

TRI(RUTILE).4(110)13.30A.

NiO

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

SPINEL. 00-8.25A.

NiO

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.10A.

Cr<sub>2</sub>O<sub>3</sub>

200 hr

COLLECTED SPALL

SPINEL. 00-8.20A.

NiO

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.10A.

02-04-003-105-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

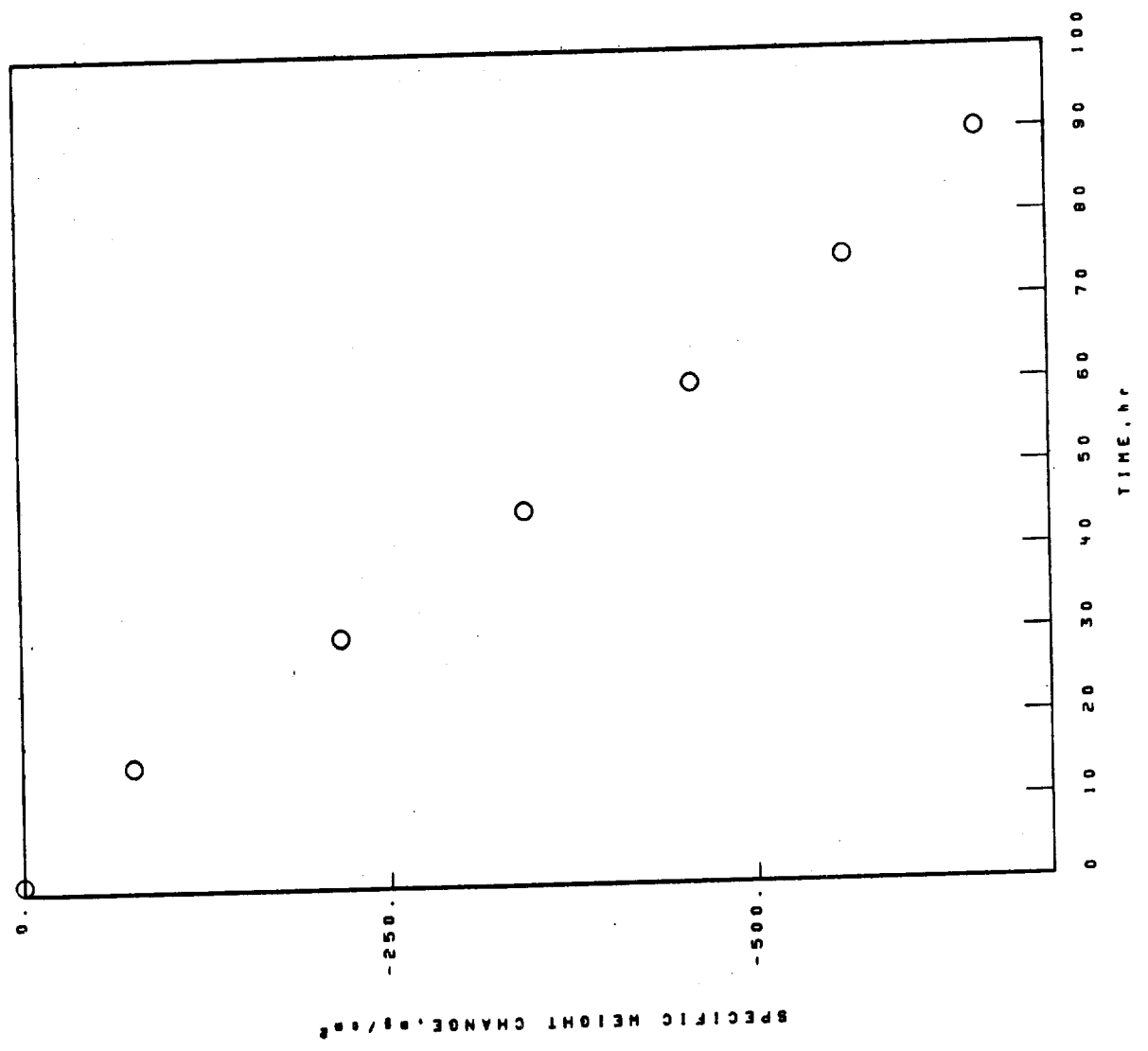
THICK 2.620

1150°C 1.00hr CYCLES 90.00hr TEST

IN-100

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta H/A, \text{g/cm}^2$
0.00	0.00
1.00	-0.01
15.00	-75.43
30.00	-217.51
45.00	-343.81
60.00	-457.74
75.00	-561.97
90.00	-652.59

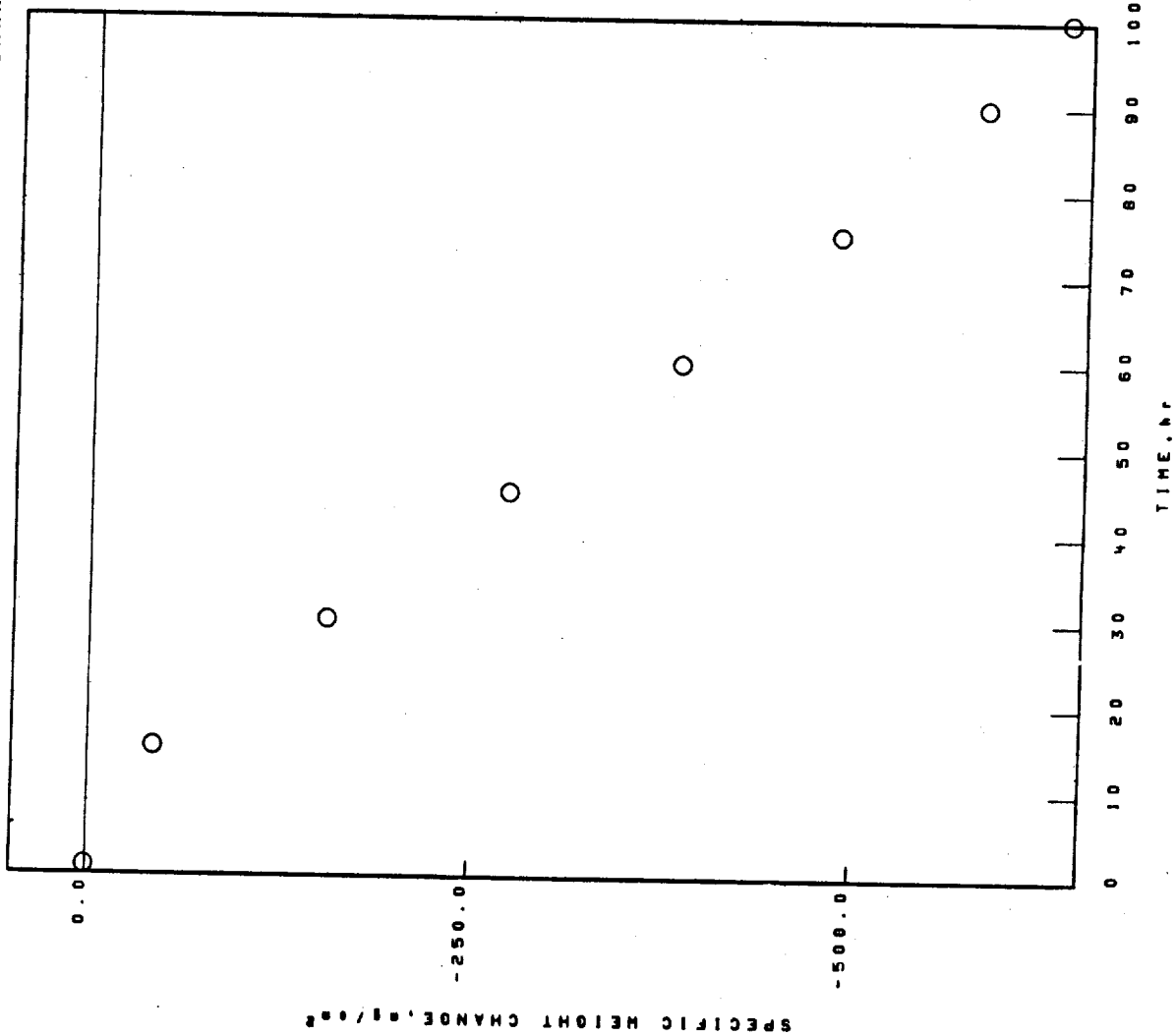


# NI BASE IN-100

02-04-003-105-2

1150°C 1.00hr CYCLES 100.00hr TEST 2.625mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔM/A, g/cm²
0.00	0.00
1.00	0.69
15.00	-42.66
30.00	-155.34
45.00	-273.51
60.00	-384.80
75.00	-487.43
90.00	-581.66
100.00	-635.19

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.625mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $a_0 = 0.25A$ .	NIO
Cr <sub>2</sub> O <sub>3</sub>	SPINEL. $a_0 = 0.20A$ .

FACE CENTERED CUBIC MATRIX

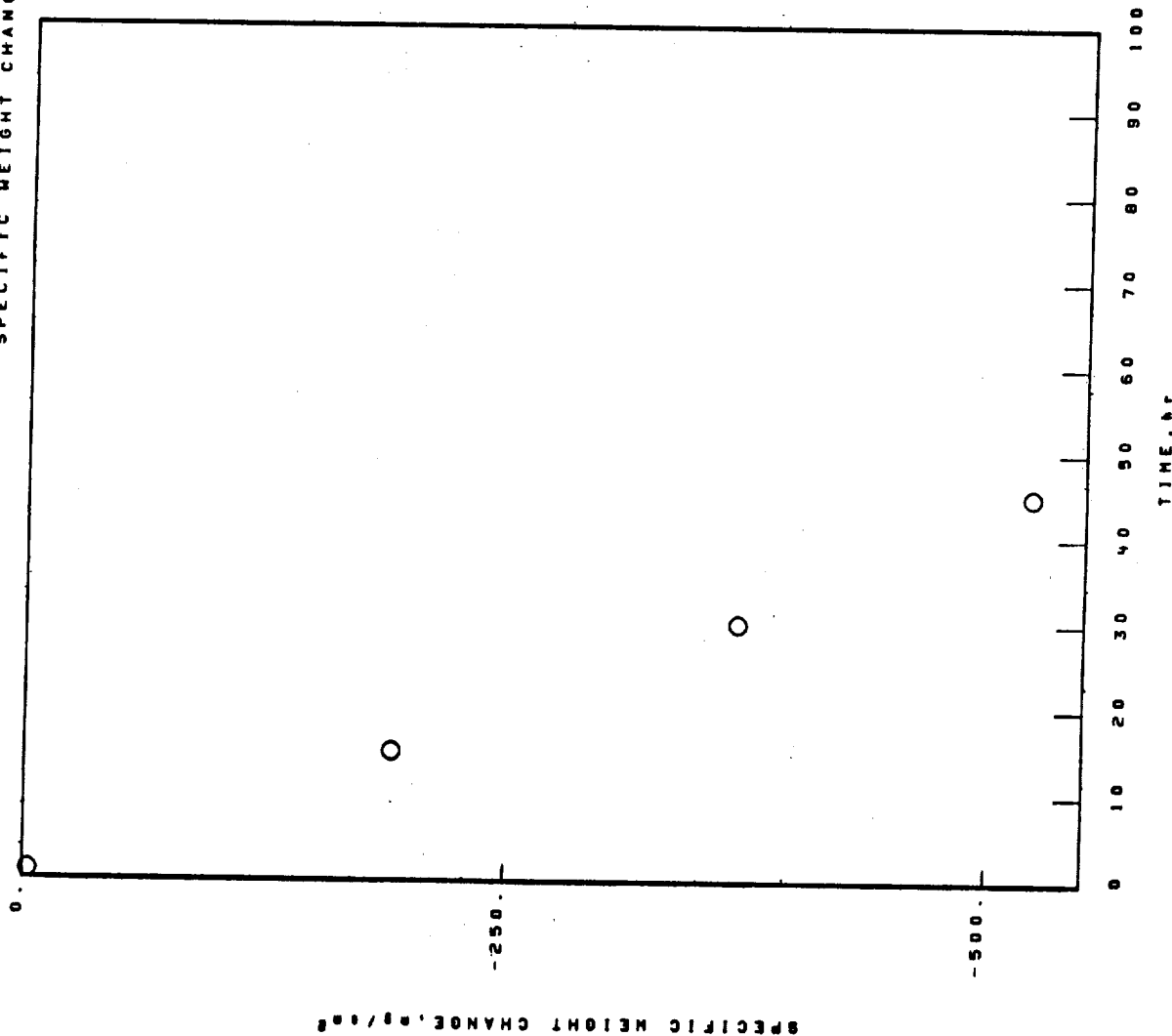
NI BASE  
IM-100

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

82-04-003-470-1

1150°C 1.00hr CYCLES 45.00hr TEST 2.256mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00

ΔW/A, mg/cm²  
0.00  
-2.91  
-190.73  
-370.12  
-521.88

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE  
IN-100  
1150°C  
1.00hr CYCLES  
45.00hr TEST  
2.256mm THICK  
STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

SPINEL,  $\theta_0$ -8.25A.(Ni,Co,F)TiO<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

45 hr

## STANDARD SURFACE

SPINEL,  $\theta_0$ -8.25A.

NiO

(Ni,Co,F)TiO<sub>3</sub>Ni(W.Mo)O<sub>4</sub> TYPE 2SPINEL,  $\theta_0$ -8.15A.

TRI(RUTILE).4(110)13.30A.

## UNKNOWN LINES. 4 VALUES

3.34A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

## COLLECTED SPALL

NiO

SPINEL,  $\theta_0$ -8.25A.

45 hr

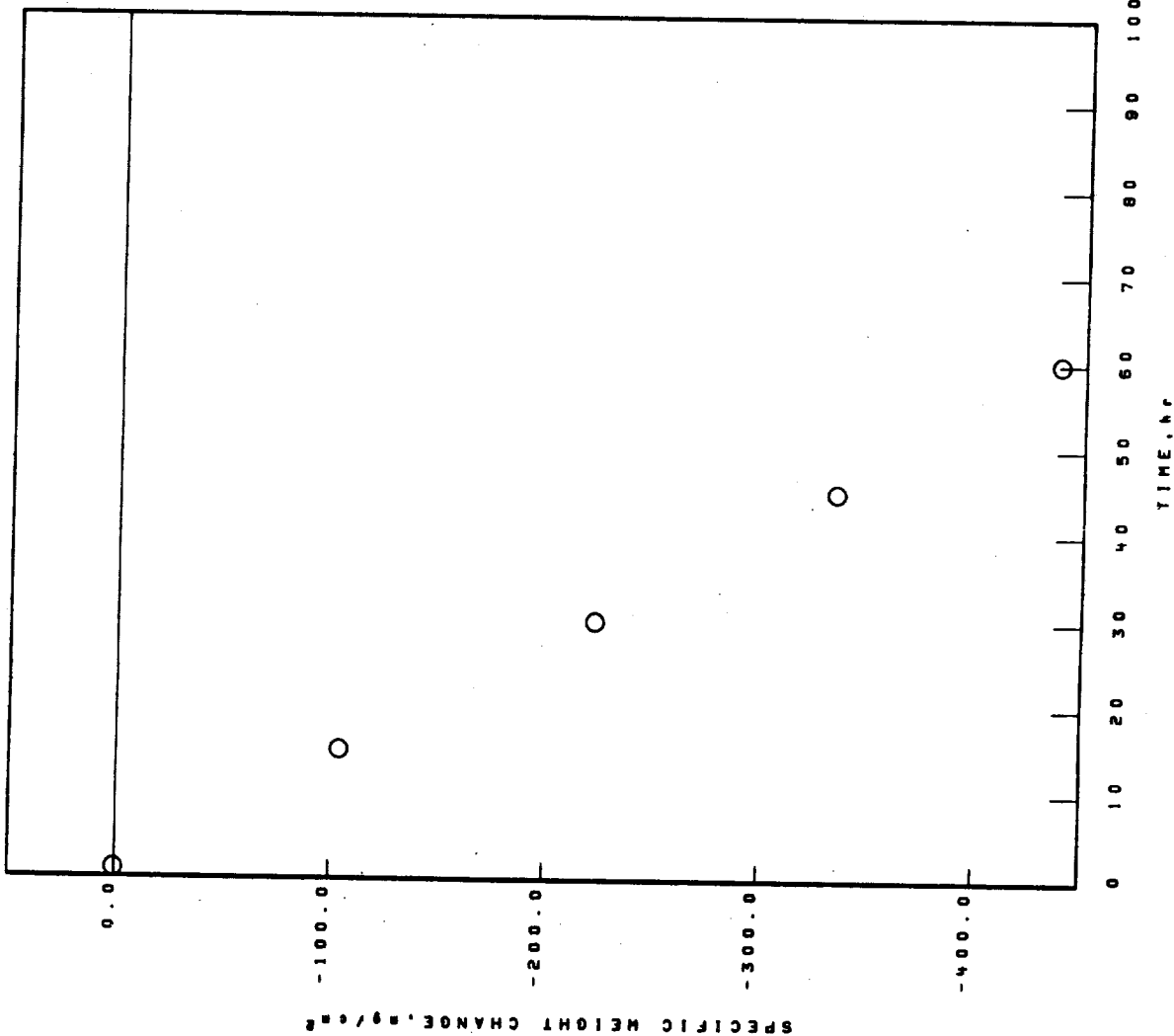
## COLLECTED SPALL

NiO

SPINEL,  $\theta_0$ -8.25A.Ni(W.Mo)O<sub>4</sub> TYPE 2

NI BASE  
 DS-IN-100  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 60.00hr TEST 2.314mm THICK STATIC AIR  
 02-04-040-414-4

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.54
15.00	-104.10
30.00	-222.74
45.00	-334.53
60.00	-438.16



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

DS-IN-100

1150°C 1.00hr CYCLES 60.00hr TEST 2.31mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

60 hr

## STANDARD SURFACE

SPINEL.  $a_0 = 8.25 \text{ \AA}$ .

Ni(W.M.)O, TYPE 2

## FACE CENTERED CUBIC MATRIX

## SPALL

60 hr

## COLLECTED SPALL

NiO

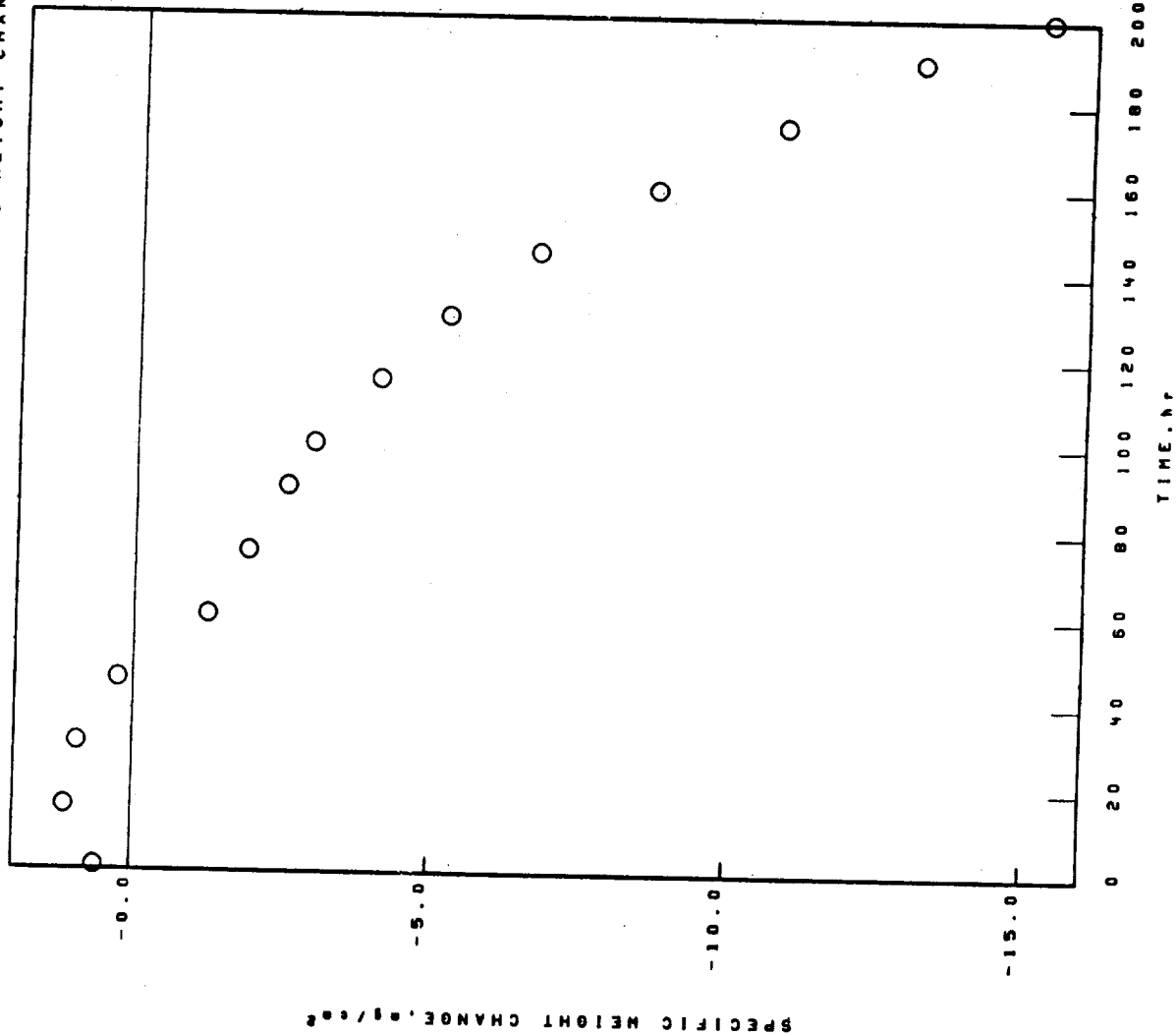
SPINEL.  $a_0 = 8.25 \text{ \AA}$ .

Ni(W.M.)O, TYPE 2

# NI BASE IN-100

1100°C 1.00hr CYCLES 200.00hr TEST 2.322mm THICK STATIC AIR 02-04-003-393-1

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 1100°C 1.00hr CYCLES 200.00hr TEST 2.322mm THICK STATIC AIR  
IN-100

## X-RAY DIFFRACTION DATA

## SURFACE

200 hr

## STANDARD SURFACE

SPINEL,  $\theta_0 = 8.15A$ .Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE), 4(110)13.30A.

(Ni,Co,Fe)TiO<sub>3</sub>SPINEL,  $\theta_0 = 8.25A$ .

## SPALL

200 hr

## PROBABLE CROSS-SPALL

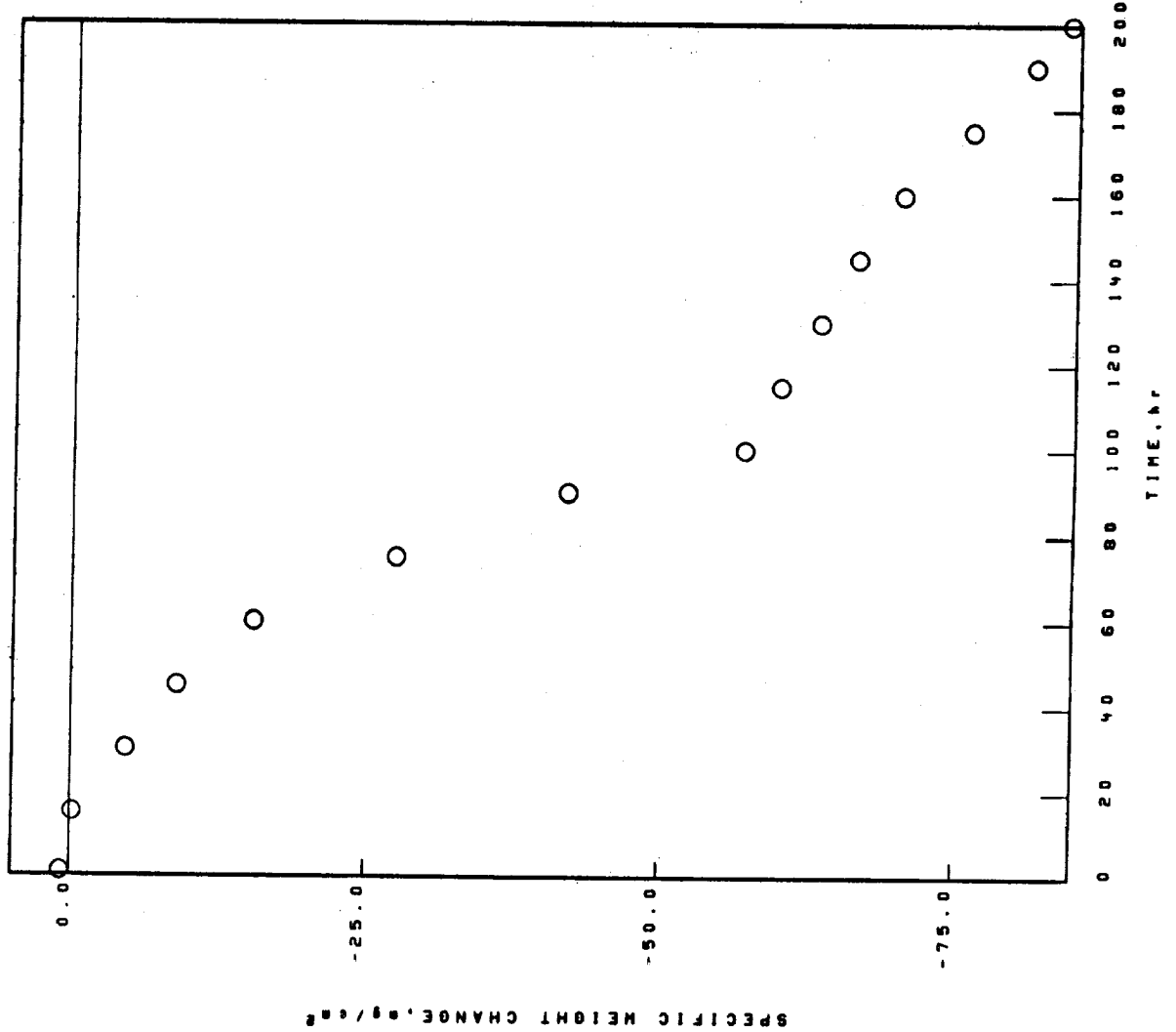
NiO

SPINEL,  $\theta_0 = 8.30A$ .

## FACE CENTERED CUBIC MATRIX

NI BASE  
IN-100  
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
1100°C 1.00hr CYCLES 200.00hr TEST 2.316mm THICK STATIC AIR  
02-04-003-468-1

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-100 1100°C 1.00hr CYCLES 200.00hr TEST 2.316mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

(Ni<sub>3</sub>Co<sub>2</sub>Fe<sub>3</sub>)TiO<sub>3</sub>SPINEL.  $\theta_0$ -8.25A.TRI(RUTILE).  $\theta_0$ (110)>3.30A.

## SPALL

1 hr

## COLLECTED SPALL

SPINEL.  $\theta_0$ -8.25A.

NiO

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.Al<sub>2</sub>O<sub>3</sub>TRI(RUTILE).  $\theta_0$ (110)>3.30A.

100 hr

## COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.30A.(Ni<sub>3</sub>Co<sub>2</sub>Fe<sub>3</sub>)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.Al<sub>2</sub>O<sub>3</sub>TRI(RUTILE).  $\theta_0$ (110)>3.30A.

200 hr

## PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta_0$ -8.25A.

## FACE CENTERED CUBIC MATRIX

# NI BASE DS-IN-100

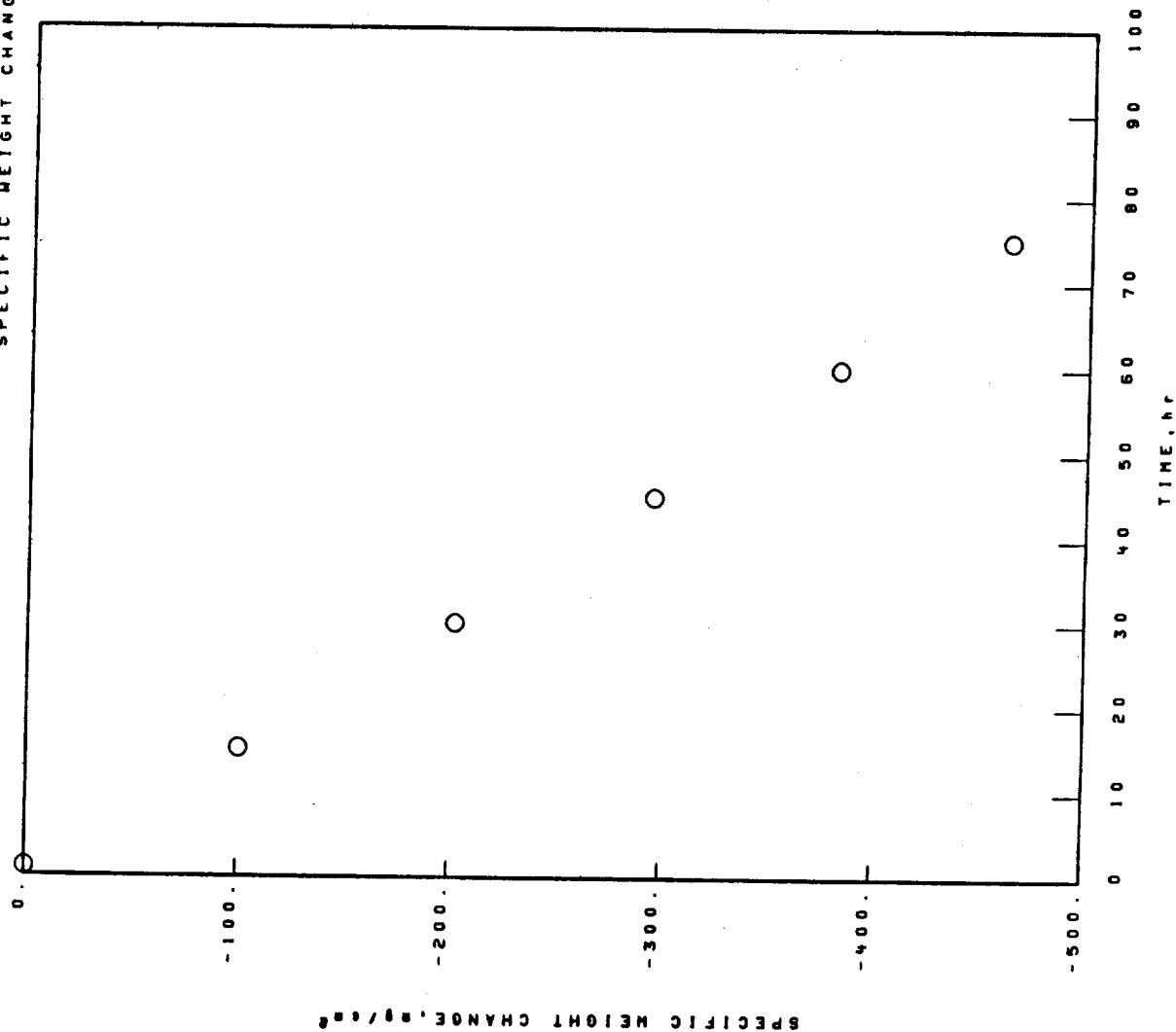
02-04-040-413-4

1100°C 1.00hr CYCLES 75.00hr TEST 2.316mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA

TIME, hr
0.00
1.00
15.00
30.00
45.00
60.00
75.00

$\Delta W/A, \text{mg/cm}^2$
0.00
-0.09
-100.36
-202.29
-295.56
-382.58
-462.44



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST 2.316

75.00hr CYCLES

1100°C

DS-IN-100

X-RAY DIFFRACTION DATA

SURFACE

75 hr

STANDARD SURFACE

SPINEL,  $\theta_0$ =8.30A.

SPINEL,  $\theta_0$ =8.15A.

NI(W,M<sub>2</sub>)O<sub>4</sub> TYPE 1

TRI(RUTILE).4(110)>3.30A.

SPALL

75 hr

COLLECTED SPALL

NiO

SPINEL,  $\theta_0$ =8.25A.

NI(W,M<sub>2</sub>)O<sub>4</sub> TYPE 2

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-713C

1150°C

1.00hr CYCLES

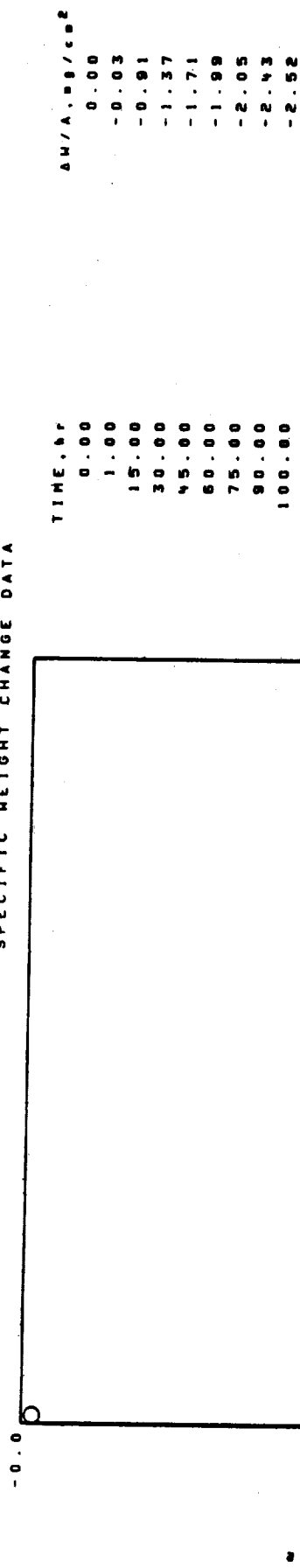
100.00hr TEST

2.171in THICK

STATIC AIR

02-04-004-472-5

SPECIFIC WEIGHT CHANGE DATA





## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

CYCLES

1150°C

IN-713C

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

SPINEL,  $\theta_0=8.10A$ .TRI(RUTILE),  $\theta_0(110)\angle 3.30A$ .Cr<sub>2</sub>O<sub>3</sub>Al<sub>2</sub>O<sub>3</sub>UNKNOWN LINES.  $\theta$  VALUES

3.40A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL,  $\theta_0=8.10A$ .Al<sub>2</sub>O<sub>3</sub>TRI(RUTILE),  $\theta_0(110)\angle 3.30A$ .

## SPALL

1 hr

## COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>TRI(RUTILE),  $\theta_0(110)\angle 3.30A$ .

100 hr

## COLLECTED SPALL

NiO

TRI(RUTILE),  $\theta_0(110)\angle 3.30A$ .SPINEL,  $\theta_0=8.25A$ .SPINEL,  $\theta_0=8.10A$ .Cr<sub>2</sub>O<sub>3</sub>

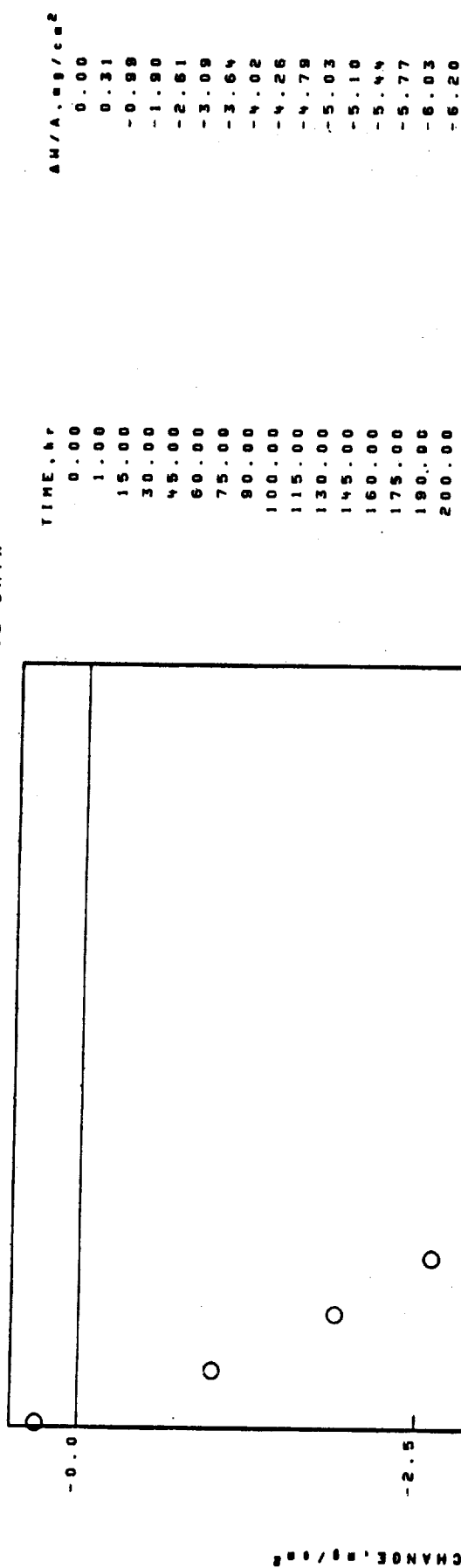
## FACE CENTERED CUBIC MATRIX

# NI BASE IN-713C

02-04-004-473-5

1100°C 1.00hr CYCLES 200.00hr TEST 2.150mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.150mm THICK STATIC AIR  
 IM-713C

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)S3.30A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL. 00-8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

SPINEL. 00-8.25A.

## FACE CENTERED CUBIC MATRIX

UNKNOWN LINES. 4 VALUES

2.12A.

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 00-8.25A.

TRI(RUTILE).4(110)S3.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

200 hr

## PROBABLE CROSS-SPALL

NiO

TRI(RUTILE).4(110)S3.30A.

SPINEL. 00-8.25A.

SPINEL. 00-8.10A.

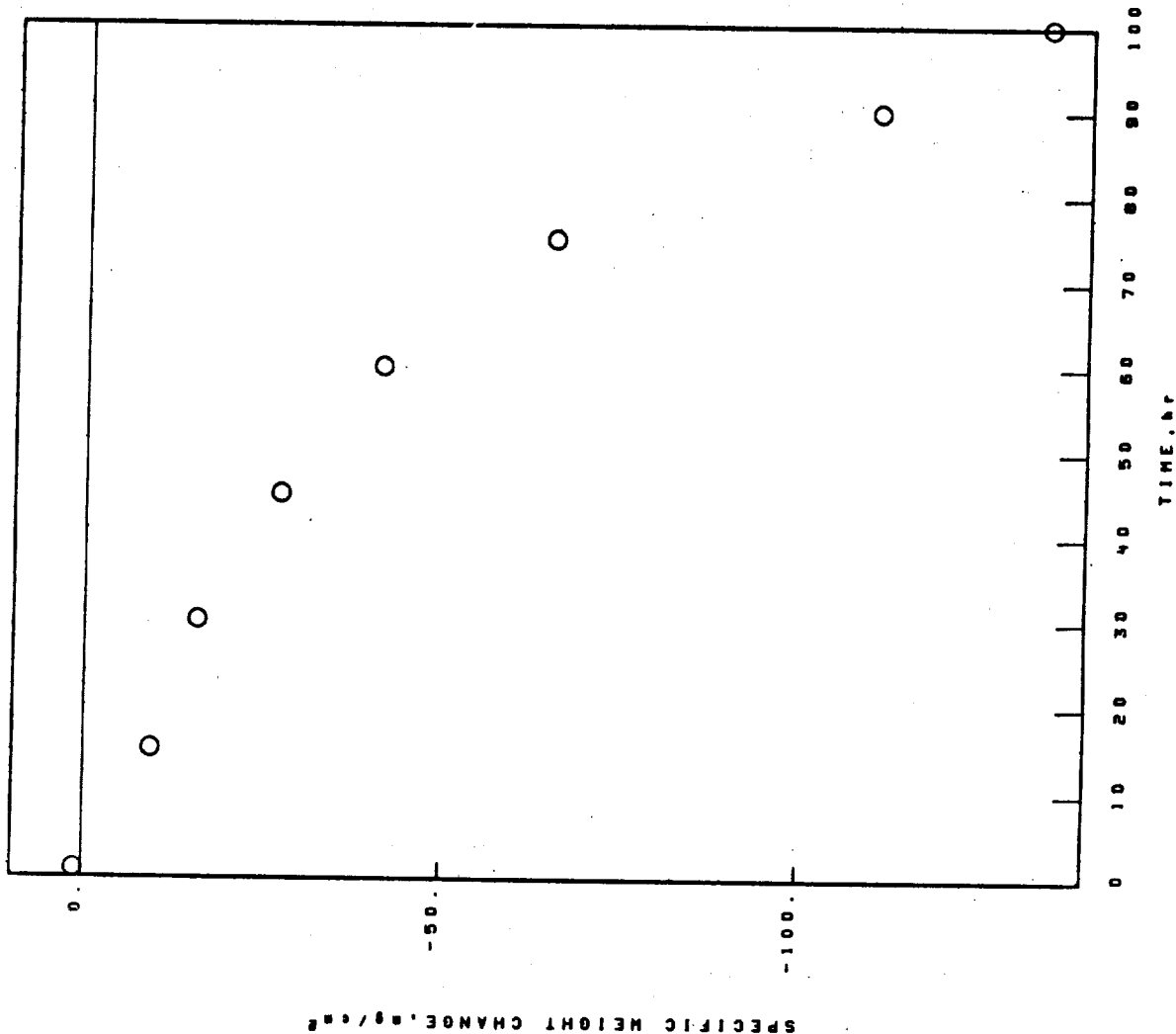
NI BASE  
IN-738

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-005-321-1

1150°C 1.00hr CYCLES 100.00hr TEST 2.321mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.12
15.00	-8.45
30.00	-15.73
45.00	-27.21
60.00	-41.31
75.00	-65.26
90.00	-110.41
100.00	-134.14

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

100.00hr CYCLES

1150°C

IM-730

## X-RAY DIFFRACTION DATA

## SURFACE

100 hr

## STANDARD SURFACE

NiO

SPINEL. 00-8-30A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE). 4(110)53.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

Ni(M.Mo)O, TYPE 2

## SPALL

100 hr

## COLLECTED SPALL

NiO

SPINEL. 00-8-30A.

TRI(RUTILE). 4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>(Ni.Co.Fe)TiO<sub>3</sub>

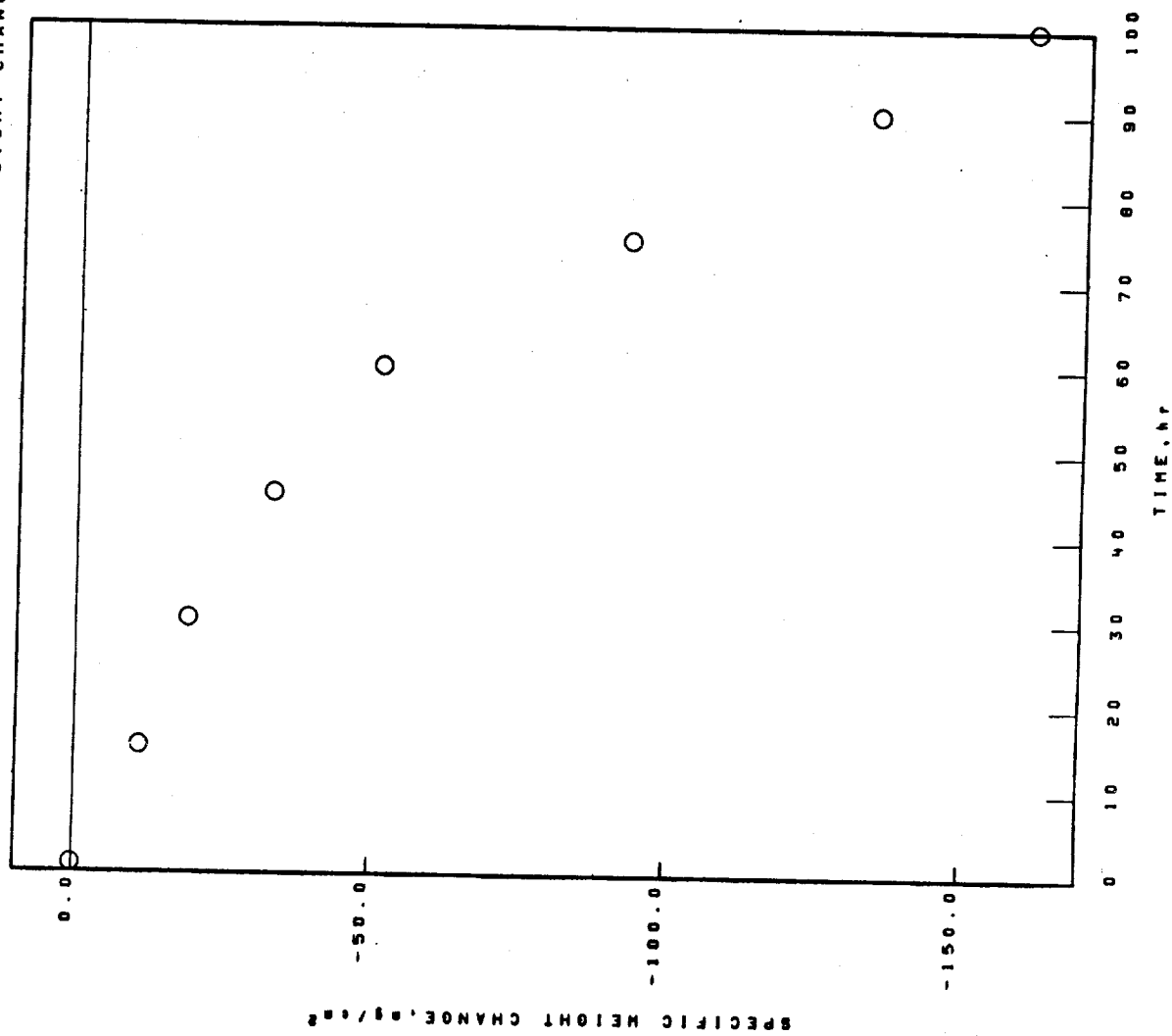
UNKNOWN LINES. 4 VALUES

2.91A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 IN-738  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.326mm THICK STATIC AIR  
 02-04-005-414-2

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.10
15.00	-11.02
30.00	-18.98
45.00	-33.15
60.00	-51.22
75.00	-93.02
90.00	-134.58
100.00	-160.77

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

100.00hr

CYCLES

1150°C

1.00hr

THICK

TEST

100.00hr

CYCLES

1150°C

1.00hr

THICK

## X-RAY DIFFRACTION DATA

## SURFACE

100 hr

## STANDARD SURFACE

NIO

SPINEL.  $a_0 = 8.30 \text{ \AA}$ .Cr<sub>2</sub>O<sub>3</sub>TRI(RUTILE).  $d(110) 53.30 \text{ \AA}$ .

## FACE CENTERED CUBIC MATRIX

## SPALL

100 hr

## COLLECTED SPALL

NIO

SPINEL.  $a_0 = 8.30 \text{ \AA}$ .TRI(RUTILE).  $d(110) 53.30 \text{ \AA}$ .Cr<sub>2</sub>O<sub>3</sub>NI(W.M.)O<sub>4</sub> TYPE 1(NI.C.F.)TiO<sub>3</sub>TRI(RUTILE).  $d(110) 53.30 \text{ \AA}$ .

NI BASE

IN-738

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1150°C

1.00hr CYCLES

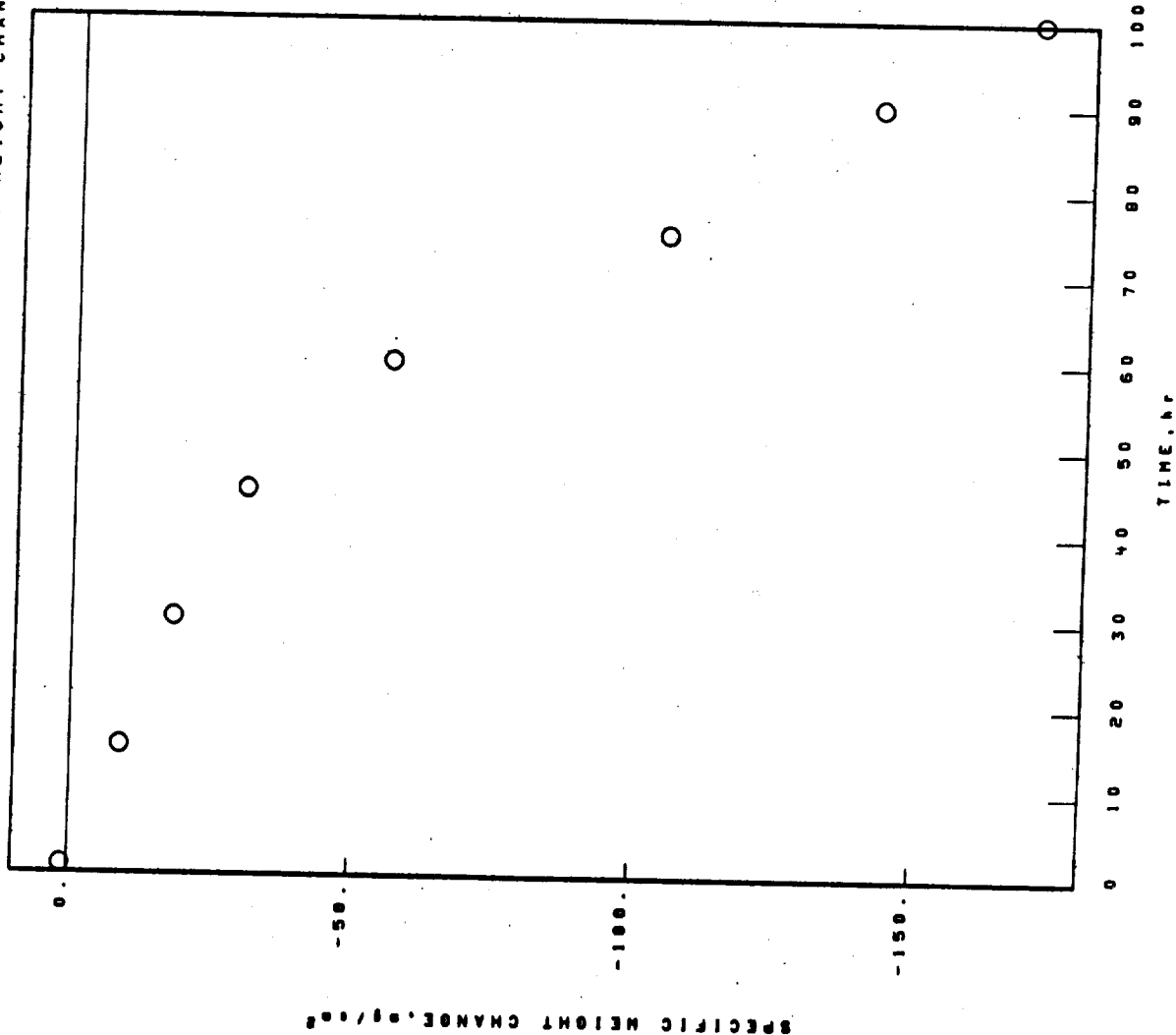
100.00hr TEST

2.294mm THICK

STATIC AIR

02-04-005-470-6

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	1.16
15.00	-8.98
30.00	-18.07
45.00	-30.79
60.00	-56.25
75.00	-104.78
90.00	-142.34
100.00	-170.58



NI BASE	COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS	02-04-005-470-6
N-738	1150°C 1.00hr CYCLES	100.00hr TEST 2.294" THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1  
2  
3

## STANDARD SURFACE

CO-2

23  
TPT (RUTILE). 4(110)  $\leq$  3.30A.

TRI(RUTILE),  $d(110) \leq 3.30 \text{ \AA}$ .

**SPALL**

1  
2  
3

COLLECTED SPALL

CC-0

TRF(RUTILE), d(110)  $\leq 3.30 \text{ \AA}$ .

**FACE CENTERED CUBIC MATRIX**

1004

## STANDARD SURFACE

012

SPINEL. #9-8.30A.

03  
2  
C

TRI(RUTILE). d(110) 53-30A.

NI (H. H. ) OF TYPE 1

(NI, Co. Fo) T103

**FACE CENTERED CUBIC MATRIX**

1004

COLLECTED SPALL

**030**

SPINEL.  $n_D = 1.30$ .

MI (M. No.) ON TYPE 1

TOP (RITILE). 4(110)53-30A.

 $(\text{Mg}, \text{Co}, \text{Fe})\text{TiO}_3$

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-738(JET SHAPES)

1150°C

1.00hr CYCLES

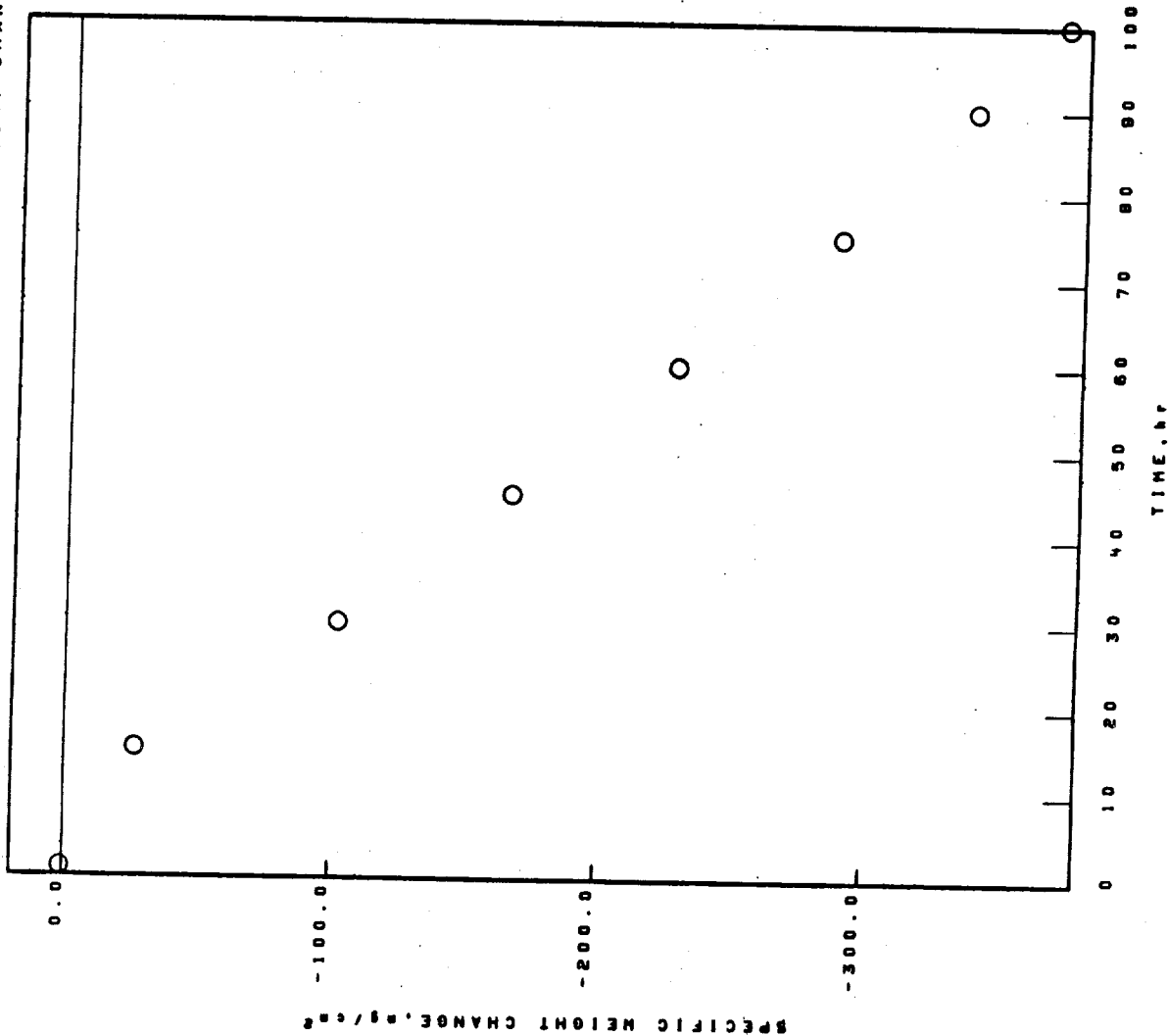
100.00hr TEST

THICK

STATIC AIR

02-04-054-658-1

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
1.00  
-26.50  
-101.00  
-166.53  
-227.93  
-288.40  
-338.27  
-371.94

° N1 BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-738 (JET SHAPES) 1150°C 1.00hr CYCLES 100.00hr TEST 2.266mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 0.8-0.25A.

NiO

(Ni,Co,Fe)TiO<sub>3</sub>ZrO<sub>2</sub>

TRI(RUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 0.8-0.25A.

Ni(Mn,Mo)O, TYPE 2

TRI(RUTILE).4(110)13.30A.

NI BASE

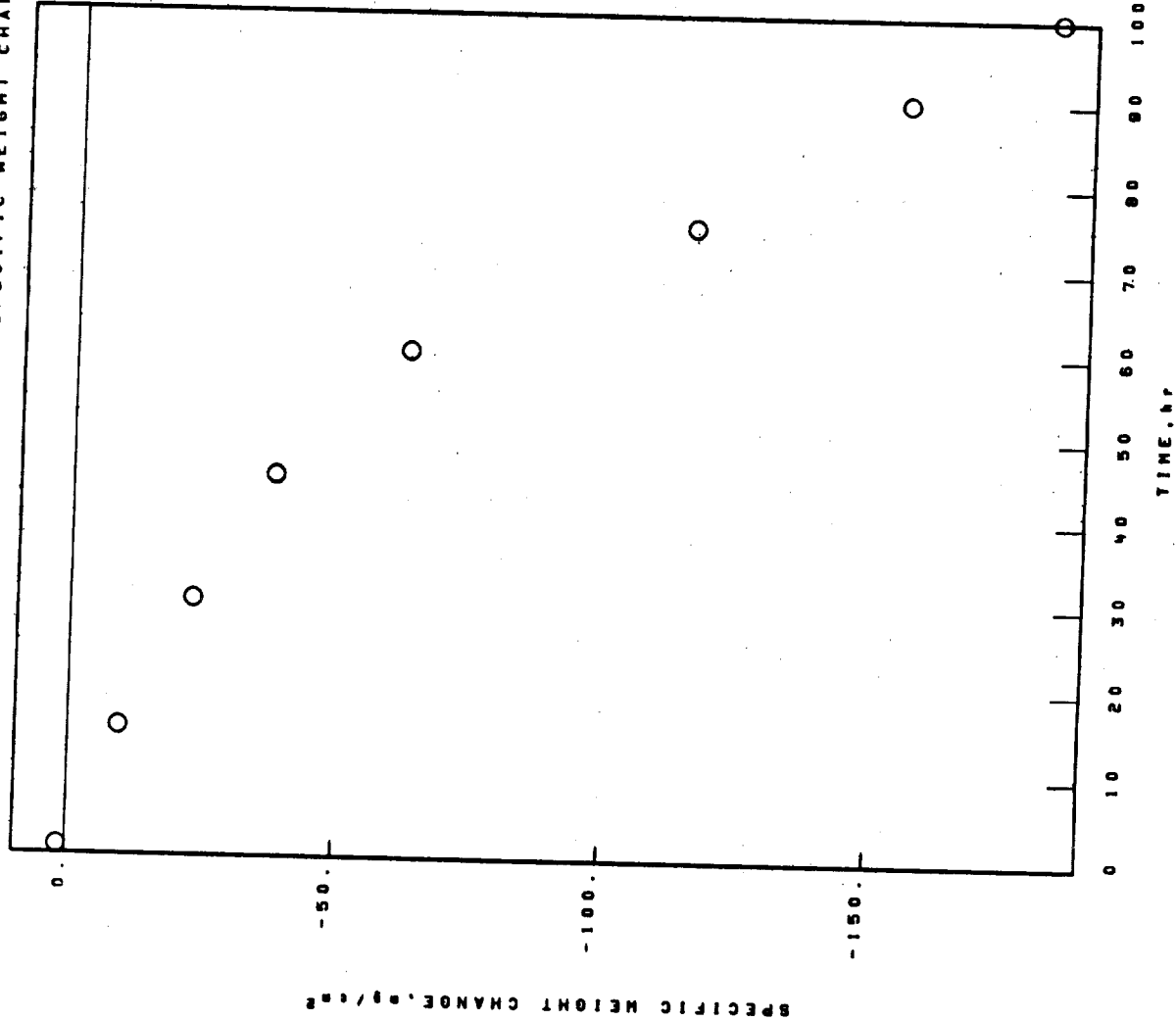
COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM IN-738-8.C.

02-13-036-663-2

1150°C 1.00hr CYCLES 100.00hr TEST 2.287mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
1.58  
-9.41  
-22.84  
-37.82  
-62.50  
-115.61  
-155.27  
-183.28

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-036-663-2  
 COSAM IN-738-B.C. 1150°C 1.00hr CYCLES 100.00hr TEST 2.297mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NI0

SPINEL,  $\theta$ =8.25A.

Cr2O3

(NI.CO.FO)TiO3

TRI(RUTILE).d(110)53.30A.

SPALL

100 hr

COLLECTED SPALL

NI0

SPINEL,  $\theta$ =8.25A.

TRI(RUTILE).d(110)53.30A.

Cr2O3

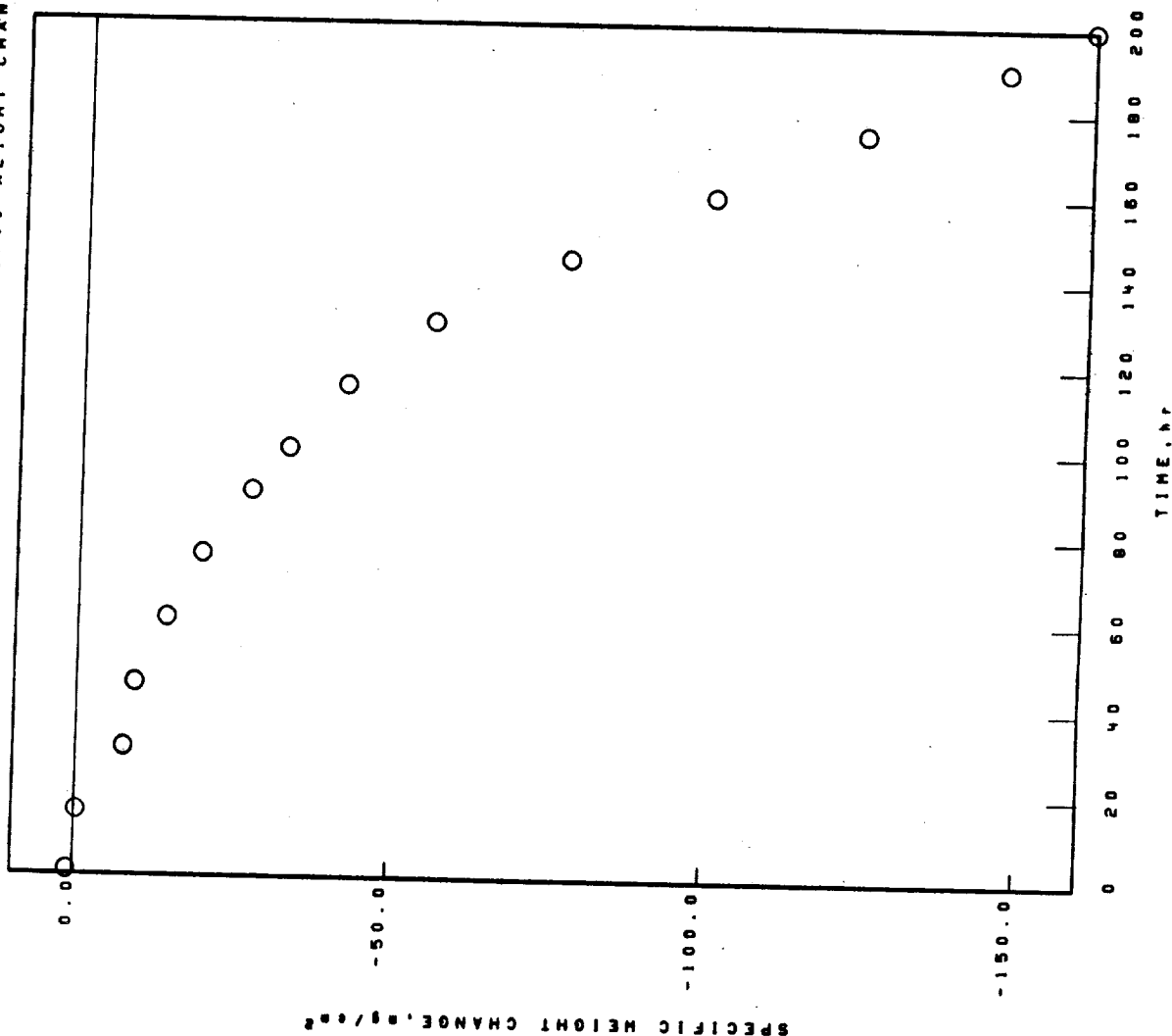
FACE CENTERED CUBIC MATRIX

NI BASE  
IN-738

02-04-005-324-1

1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 IN-738  
 1100°C  
 1.00hr  
 200.00hr  
 TEST  
 2.330mm  
 THICK  
 STATIC AIR  
 02-04-005-324-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

X-RAY DIFFRACTION DATA

SURFACE  
200 hr

STANDARD SURFACE

NiO

SPINEL,  $a_0 = 8.30 \text{ \AA}$ .

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE),  $d(110) 53.30 \text{ \AA}$ .

(Ni.Co.Fe)TiO<sub>3</sub>

UNKNOWN LINES, 4 VALUES

2.88 \AA.

FACE CENTERED CUBIC MATRIX

SPALL

200 hr

COLLECTED SPALL

NiO

SPINEL,  $a_0 = 8.30 \text{ \AA}$ .

TRI(RUTILE),  $d(110) 53.30 \text{ \AA}$ .

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES, 4 VALUES

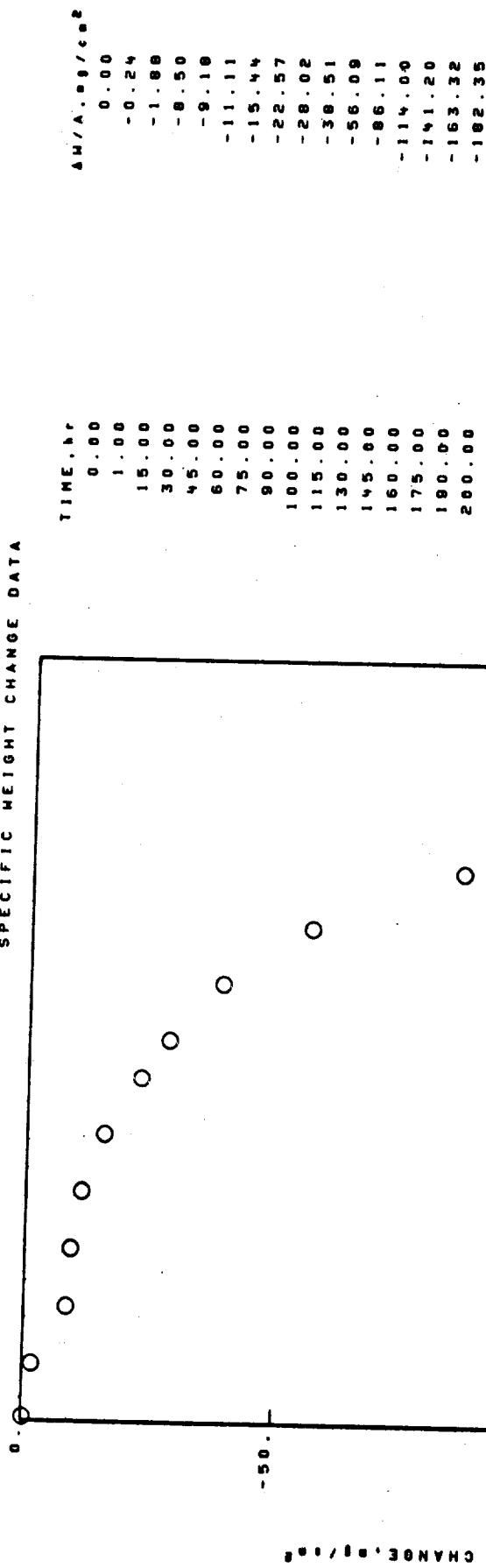
2.98 \AA.

# NI BASE 1N-730

02-04-005-413-2

1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA





NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-005-413-2  
 IN-738                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.324mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Cr,Fe)TiO<sub>3</sub>  
 SPINEL.  $\theta$ -8.10A.

FACE CENTERED CUBIC MATRIX

SPALL

200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -8.25A.  
 SPINEL.  $\theta$ -8.10A.  
 TRI(RUTILE).  $\theta$ (110)53.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-738

1100°C

1.00hr CYCLES

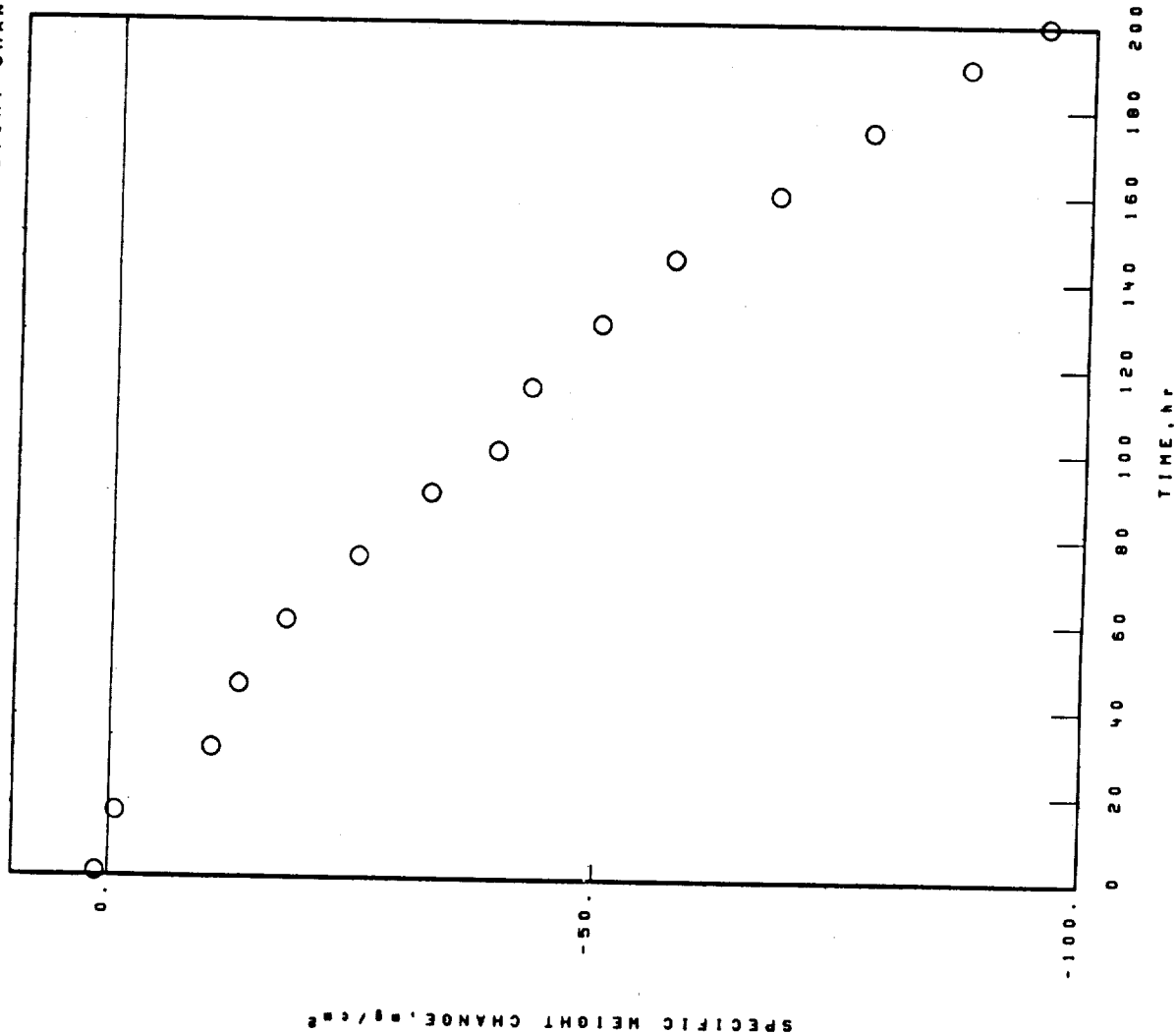
200.00hr TEST

2.326mm THICK

STATIC AIR

02-04-005-469-6

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cm²  
0.00  
1.30  
-0.64  
-10.45  
-13.20  
-17.95  
-25.30  
-32.58  
-39.35  
-42.70  
-49.75  
-57.20  
-67.84  
-77.30  
-87.14  
-95.13

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1N-738 1100°C 1.00hr CYCLES 200.00hr TEST 2.326mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL. 8-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 8-8.10A.

TRI(RUTILE).4(110)S3.30A.

TRI(RUTILE).4(110)S3.30A.

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 8-8.25A.

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO

SPINEL. 8-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O<sub>4</sub> TYPE 1

200 hr

COLLECTED SPALL

NiO

SPINEL. 8-8.25A.

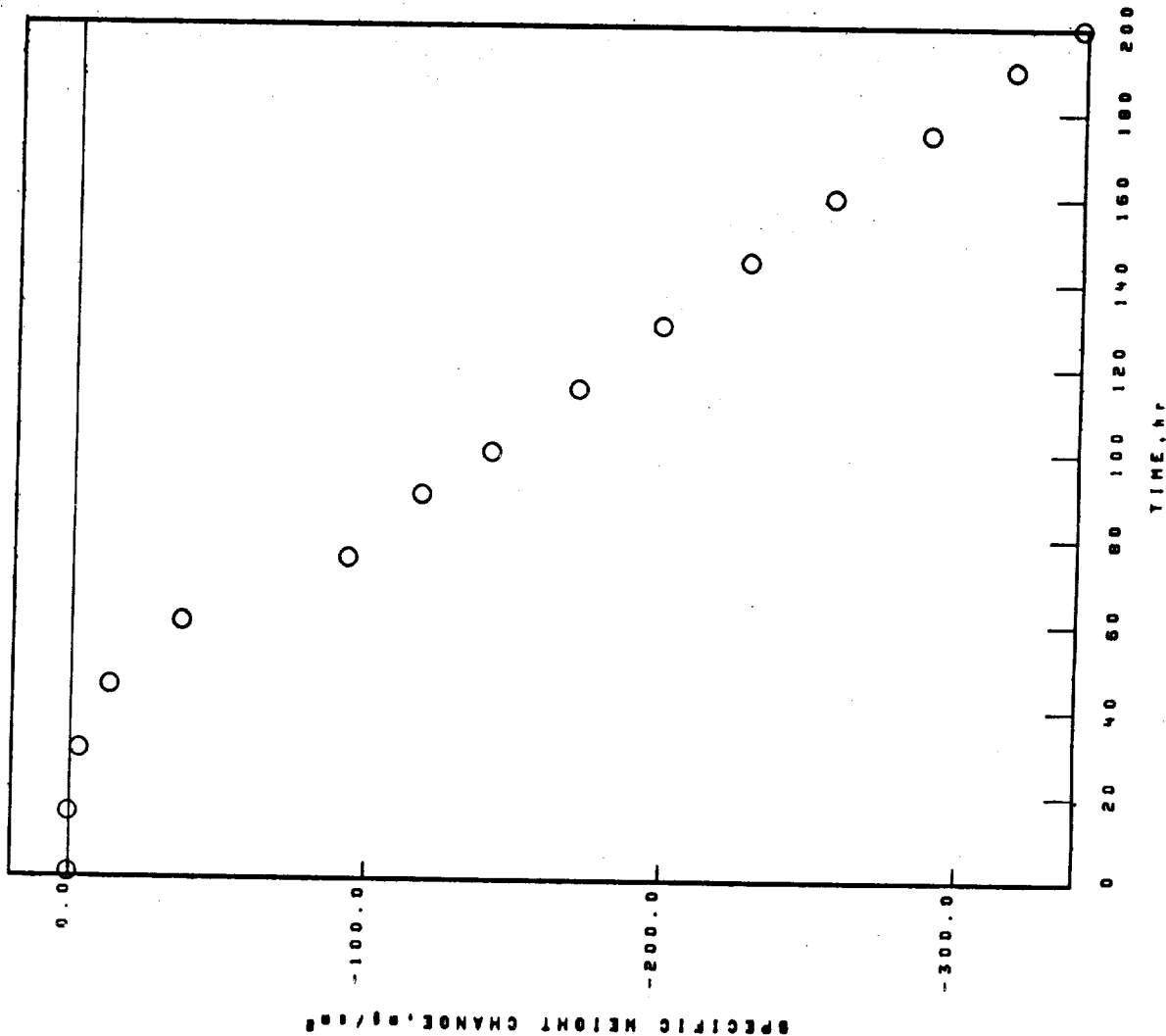
TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O<sub>4</sub> TYPE 1

Cr<sub>2</sub>O<sub>3</sub>

NI BASE  
 IN-738 (JET SHAPES)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.271mm THICK  
 02-04-054-659-1  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
 0.00  
 1.00  
 15.00  
 30.00  
 45.00  
 60.00  
 75.00  
 90.00  
 100.00  
 115.00  
 130.00  
 145.00  
 160.00  
 175.00  
 190.00  
 200.00

ΔH/A, g/cm²  
 0.00  
 0.45  
 0.64  
 -2.84  
 -12.84  
 -36.96  
 -92.90  
 -117.53  
 -140.99  
 -170.05  
 -197.97  
 -227.33  
 -255.55  
 -287.81  
 -315.86  
 -338.39

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-054-659-1  
IN-738 (JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.271in THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
1 hr  
STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)13.30A.  
Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

100 hr  
STANDARD SURFACE  
SPINEL. 00-8.25A.  
NiO  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)13.30A.  
Ni(W.M.)O, TYPE 2  
Ni(W.M.)O, TYPE 1

FACE CENTERED CUBIC MATRIX

200 hr  
STANDARD SURFACE  
SPINEL. 00-8.30A.  
NiO  
Cr<sub>2</sub>O<sub>3</sub>  
(Ni,Ce,Fe)TiO<sub>3</sub>  
TRI(RUTILE).4(110)13.30A.  
Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

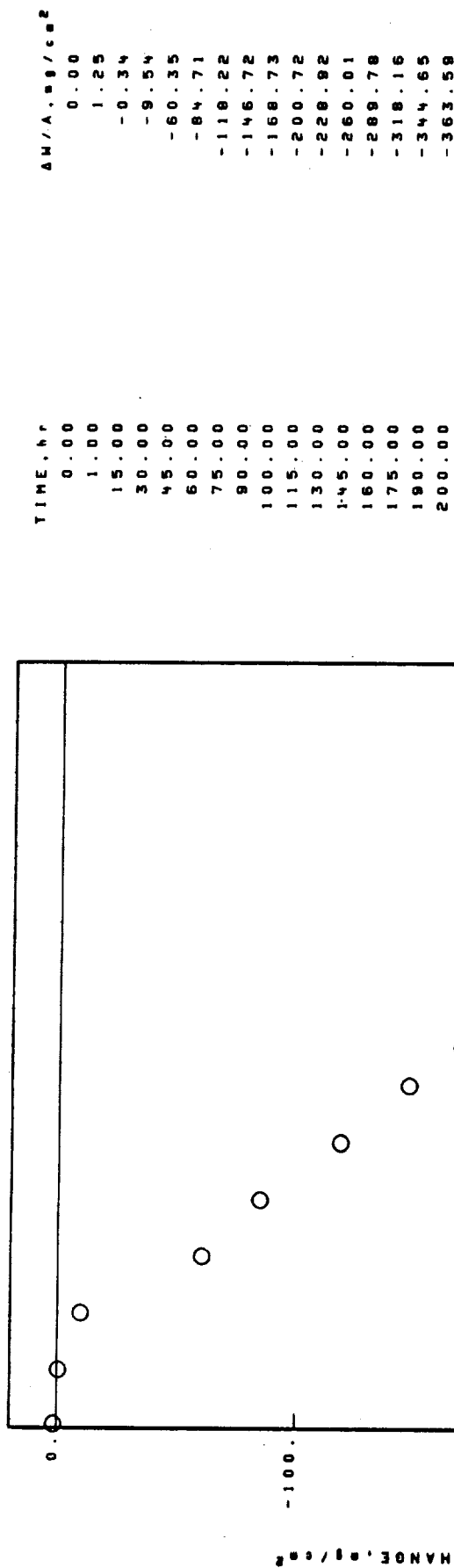
200 hr  
COLLECTED SPALL  
NiO  
SPINEL. 00-8.30A.  
Ni(W.M.)O, TYPE 1  
Ni(W.M.)O, TYPE 2  
(Ni,Ce,Fe)TiO<sub>3</sub>  
Cr<sub>2</sub>O<sub>3</sub>

SPALL

1 hr  
NO SIGNIFICANT SPALL OBSERVED

NI BASE  
 IN-738 (JET SHAPES)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.270 THICK STATIC AIR  
 02-04-054-679-4

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-738(JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.270mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRIRUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL.  $\theta_0=8.30A$ .

NiO

ZrO<sub>2</sub>Cr<sub>2</sub>O<sub>3</sub>SPINEL.  $\theta_0=8.10A$ .

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

NiO

SPINEL.  $\theta_0=8.30A$ .Ni(W.M.)O<sub>4</sub> TYPE 1Ni(W.M.)O<sub>4</sub> TYPE 2Cr<sub>2</sub>O<sub>3</sub>(Ni.Co.Fe)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL.  $\theta_0=8.30A$ .ZrO<sub>2</sub>

200 hr

## PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta_0=8.35A$ .Ni(W.M.)O<sub>4</sub> TYPE 1Ni(W.M.)O<sub>4</sub> TYPE 2

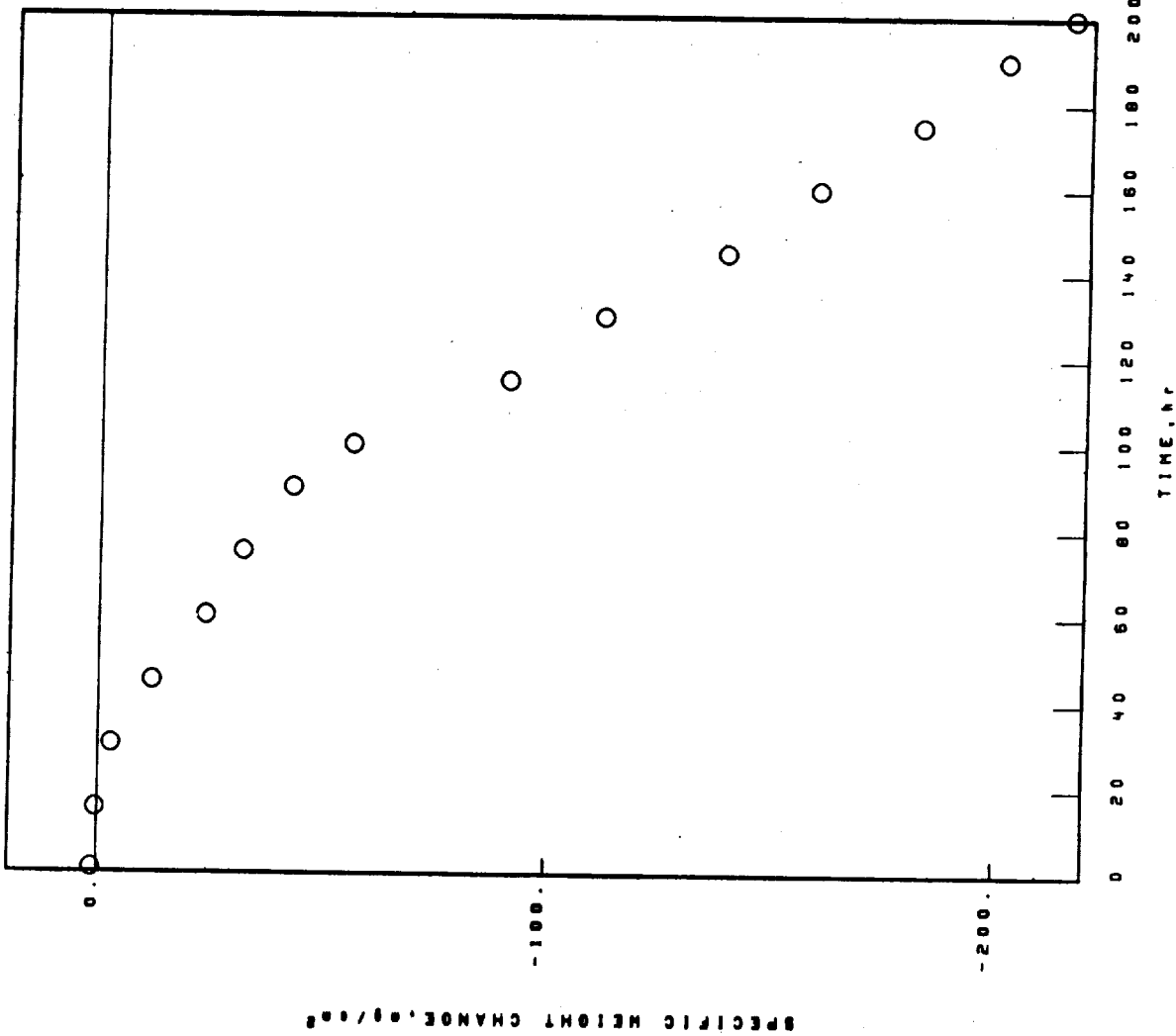
NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-054-679-5

IN-738 (JET SHAPES)

1100°C 1.00hr CYCLES 200.00hr TEST 2.262mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.24
15.00	0.58
30.00	-2.75
45.00	-11.80
60.00	-23.68
75.00	-31.77
90.00	-42.84
100.00	-56.17
115.00	-80.96
130.00	-111.90
145.00	-138.87
160.00	-159.48
175.00	-182.28
190.00	-200.97
200.00	-215.77



## NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-738 (JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.262mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

NiO

SPINEL. 80-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

NiO

SPINEL. 80-8.30A.

Ni(W.M.)O, TYPE 1

Ni(W.M.)O, TYPE 2

Cr<sub>2</sub>O<sub>3</sub>(Ni.Cr.Fe)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 80-8.30A.

TRI(RUTILE).4(110)53.30A.

200 hr

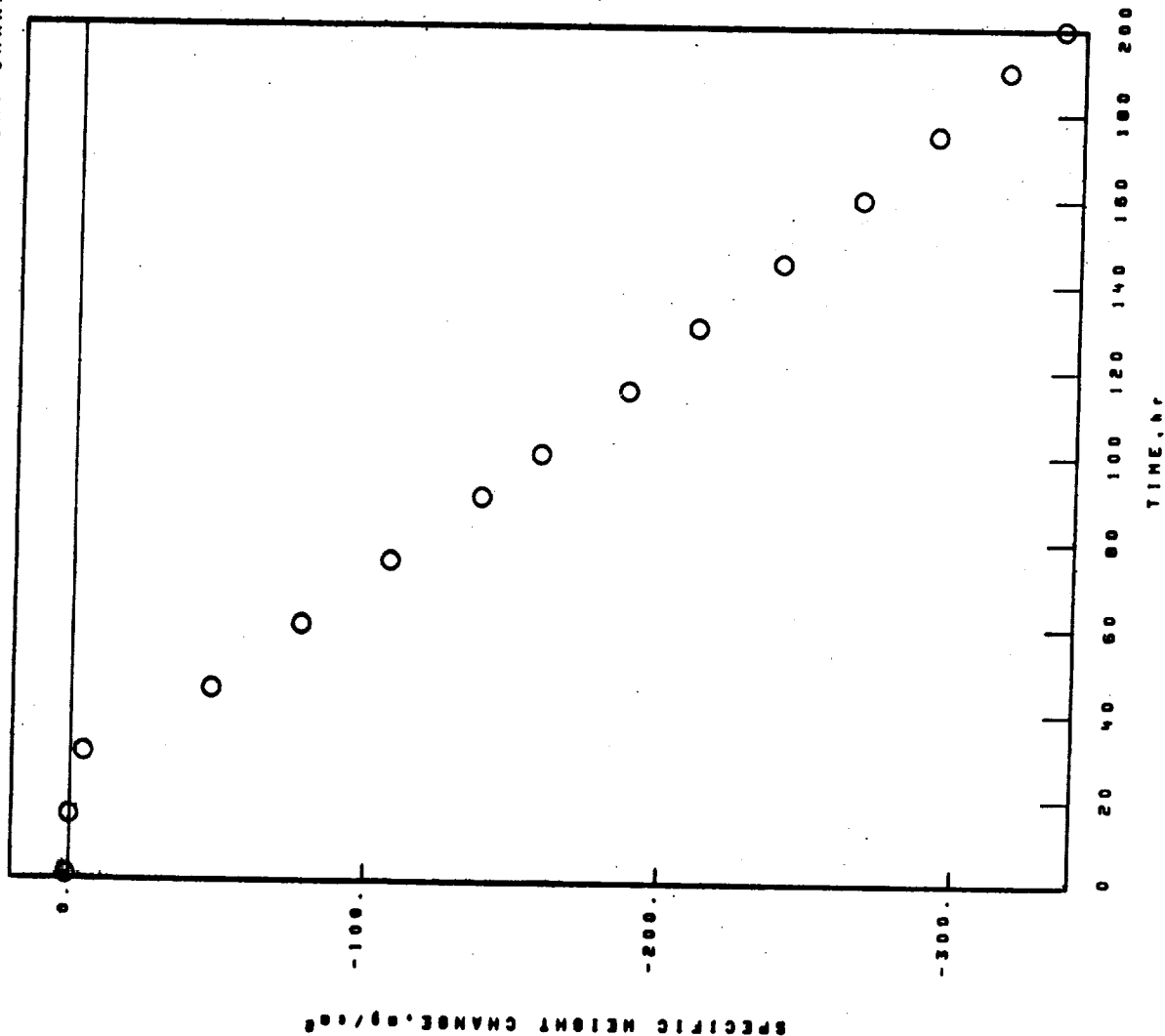
## PROBABLE CROSS-SPALL

NiO

SPINEL. 80-8.35A.

MI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-054-600-4  
 IN-738(JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.274in THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-054-680-4  
 IN-738(JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.274mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 80-8.30A.  
 NiO  
 Ni(W.M.)O, TYPE 1  
 Ni(W.M.)O, TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 80-8.30A.  
 Ni(W.M.)O, TYPE 1

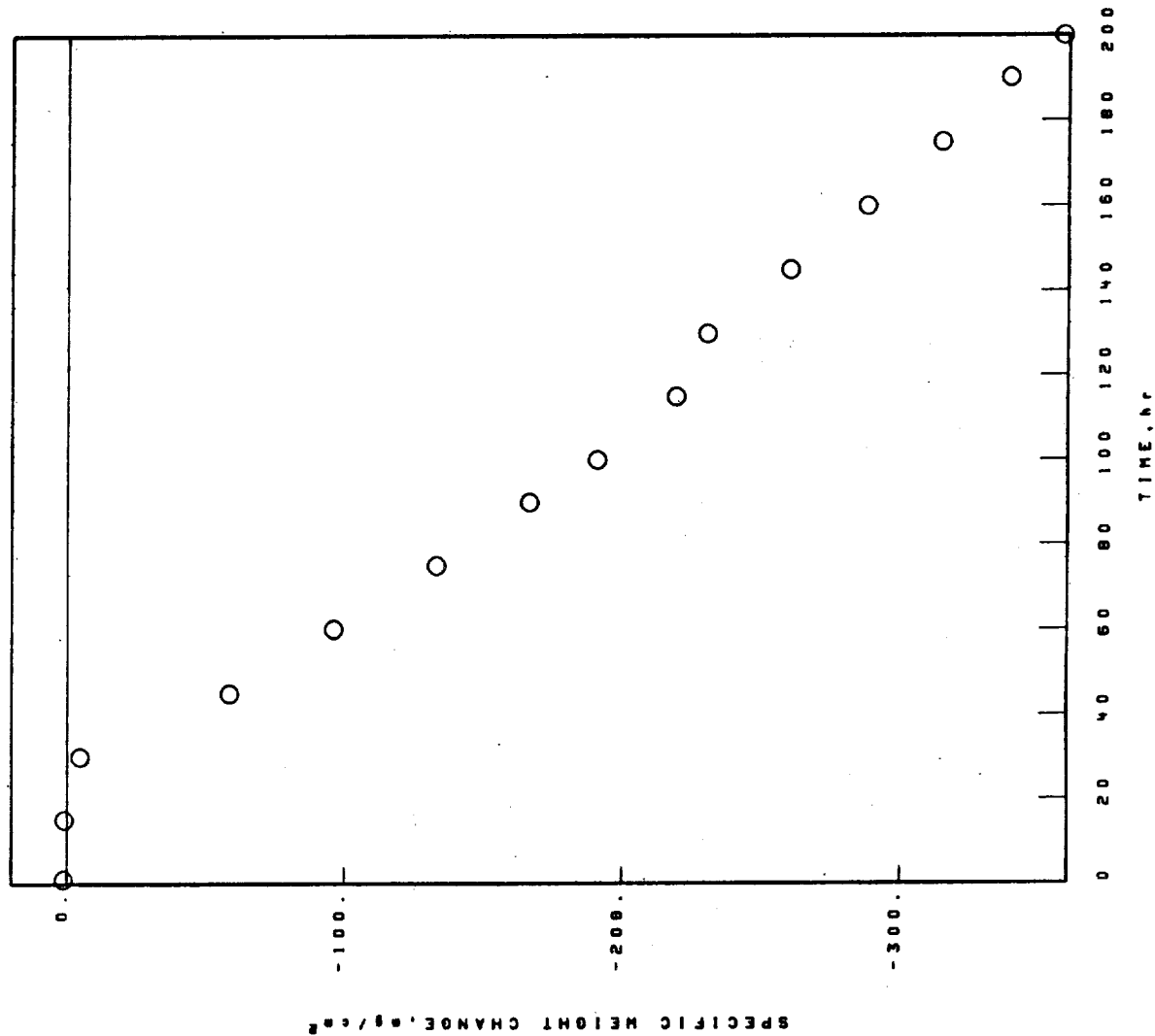
FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL. 80-8.30A.  
 Ni(W.M.)O, TYPE 1  
 Ni(W.M.)O, TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 200 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 SPINEL. 80-8.35A.  
 Ni(W.M.)O, TYPE 1  
 Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-054-680-5  
 IN-738(JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.272mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	1.16
15.00	0.93
30.00	-4.87
45.00	-58.41
60.00	-85.96
75.00	-132.93
90.00	-166.35
100.00	-190.87
115.00	-219.12
130.00	-230.21
145.00	-259.95
160.00	-287.64
175.00	-314.44
190.00	-338.95
200.00	-357.93

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-738(JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.272mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

SURFACE SPALL  
 1 hr  
 STANDARD SURFACE NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

## FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE COLLECTED SPALL  
 SPINEL. 98-8.30A.  
 NiO  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 Ni(W.M.)<sub>10</sub>, TYPE 2

Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

## FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE PROBABLE CROSS-SPALL  
 NiO  
 SPINEL. 98-8.35A.  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 Ni(W.M.)<sub>10</sub>, TYPE 2

Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM IN-738-B.C.

1100°C

1.00hr CYCLES

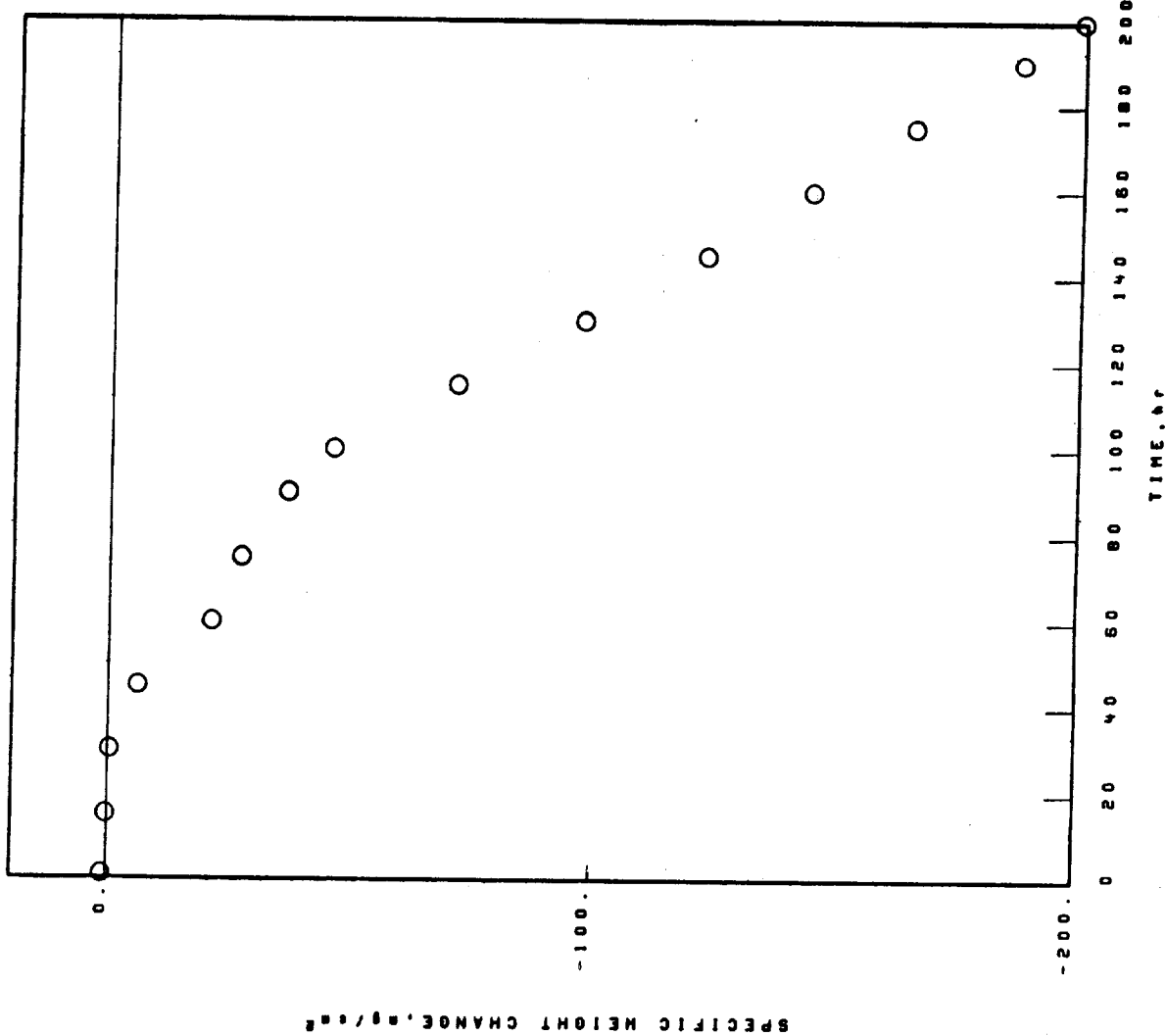
200.00hr TEST

2.293mm THICK

STATIC AIR

02-13-036-664-2

SPECIFIC WEIGHT CHANGE DATA



° NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-036-684-2  
 COSAH IN-738-8.C. 1100°C 1.00hr CYCLES 209.00hr TEST 2.293mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)S3.30A.  
 TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO  
 SPINEL.  $\theta_0$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO  
 SPINEL.  $\theta_0$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO  
 SPINEL.  $\theta_0$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)S3.30A.  
 SPINEL.  $\theta_0$ -8.10A.

200 hr

COLLECTED SPALL

NiO  
 SPINEL.  $\theta_0$ -8.25A.  
 TRI(RUTILE).4(110)S3.30A.  
 SPINEL.  $\theta_0$ -8.10A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>

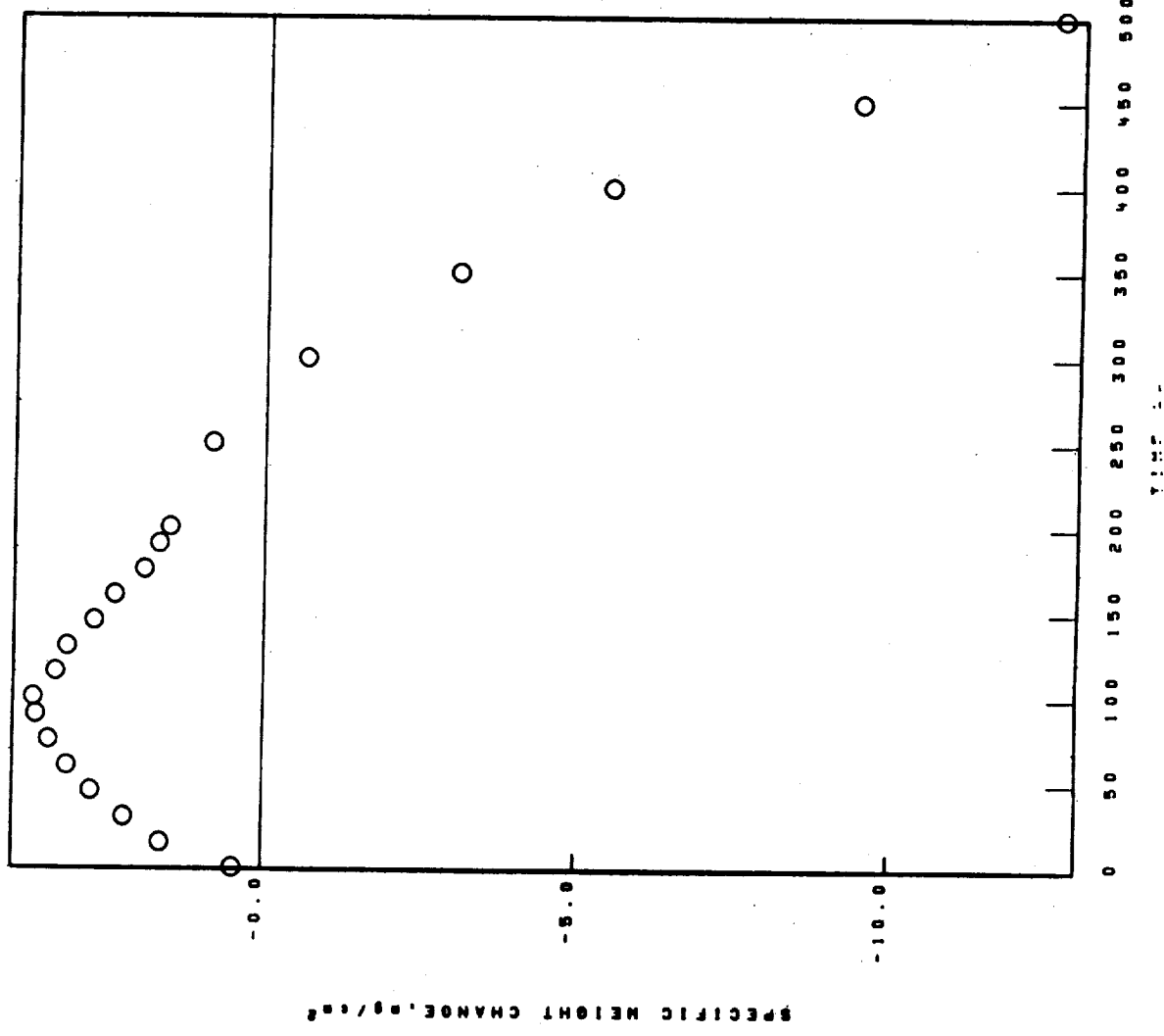
NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-036-674-3

COSAH IN-738-B.C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.296mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, %/hr
0.00	0.00
1.00	0.48
15.00	1.63
30.00	2.21
45.00	2.75
60.00	3.13
75.00	3.42
90.00	3.64
100.00	3.68
115.00	3.33
130.00	2.14
145.00	2.72
160.00	2.38
175.00	1.92
190.00	1.68
200.00	1.52
250.00	0.84
300.00	-0.64
350.00	-3.07
400.00	-5.49
450.00	-8.45
500.00	-12.88



N1 BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM IN-738-B-C<sub>0</sub> 1000°C 1.00hr CYCLES 500.00hr TEST 2.296mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

.12 Cr-.78 Ti-1.74 O

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

.12 Cr-.78 Ti-1.74 O

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.30A.

NiO

TRI(RUTILE).4(110)S3.30A.

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

NiO

500 hr

COLLECTED SPALL

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.30A.

Ni(M.M.)O<sub>4</sub> TYPE I

TRI(RUTILE).4(110)S3.30A.

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-007-323-2

IN-792

1150°C

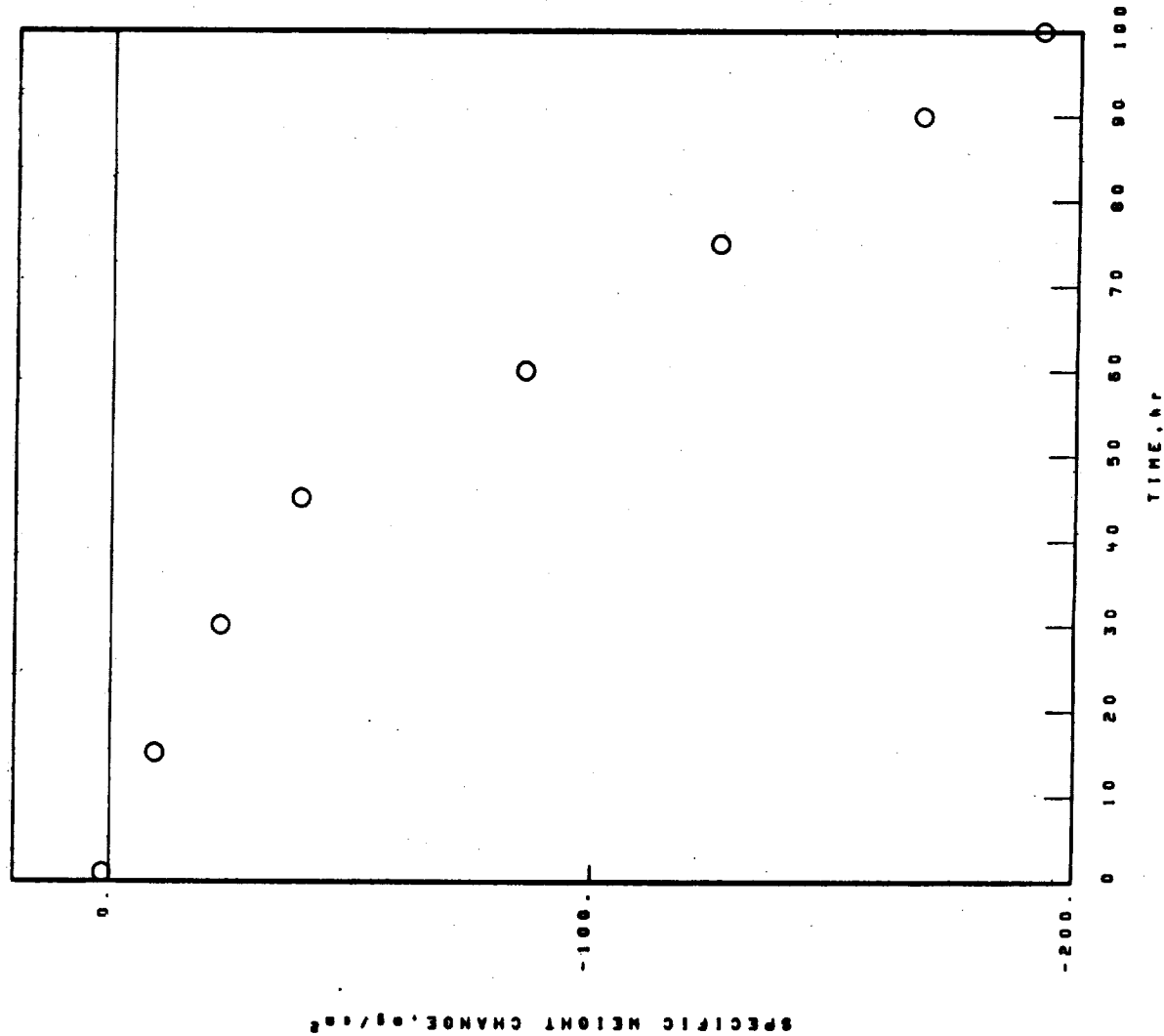
1.00hr CYCLES

100.00hr TEST

2.316mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
1.50  
-9.27  
-22.74  
-38.28  
-85.60  
-125.66  
-167.49  
-192.13

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792 1150°C 1.00hr CYCLES 100.00hr TEST 2.316mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NiO

SPINEL.  $\alpha$ - $\text{FeO}$ .30A.

Cr<sub>2</sub>O<sub>3</sub>

(Mn,Cr,Fe)TiO<sub>3</sub>

TRIRUTILE).4(110)53.30A.

Ni(Mn,Mo)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NiO

SPINEL.  $\alpha$ - $\text{FeO}$ .30A.

Ni(Mn,Mo)O<sub>4</sub> TYPE 1

TRIRUTILE).4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>

NI BASE

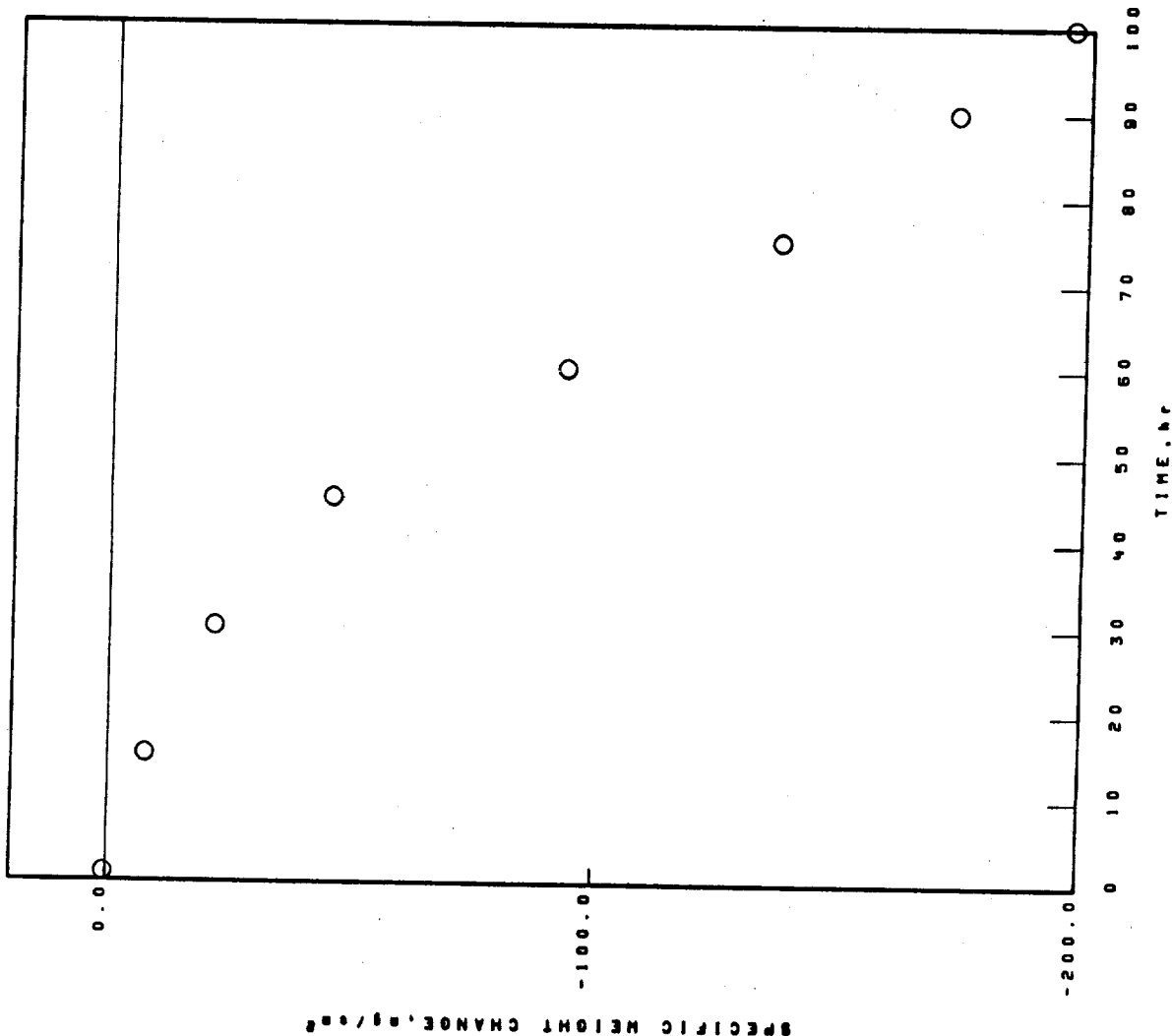
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IM-782

02-04-006-323-5

1150°C 1.00hr CYCLES 100.00hr TEST 2.236mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-006-323-5  
 1N-792 1150°C 1.00hr CYCLES 100.00hr TEST 2.236mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 SPINEL. 90-8.30A.  
 NiO  
 Ni(W.M.)O, TYPE 1  
 TRI(RUTILE). 4(110) 53.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL  
 100 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 SPINEL. 90-8.30A.  
 Ni(W.M.)O, TYPE 1  
 TRI(RUTILE). 4(110) 53.30A.  
 CrO  
 Ni(W.M.)O, TYPE 2

NI BASE

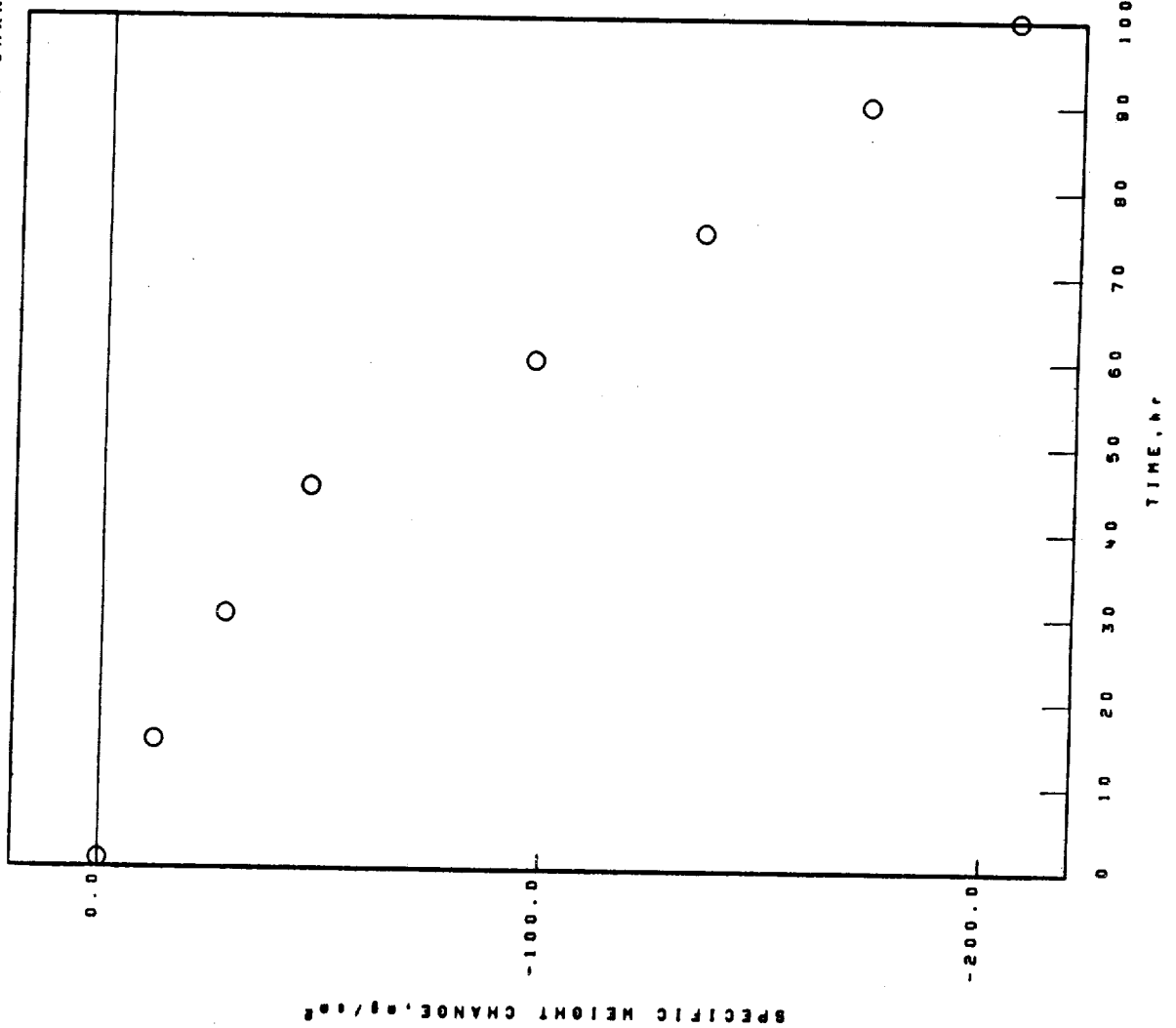
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

02-04-007-337-5

1150°C 1.00hr CYCLES 100.00hr TEST 2.322mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.08  
-12.32  
-27.79  
-46.69  
-97.05  
-134.85  
-171.67  
-204.98

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 1150°C 1.00hr CYCLES 100.00hr TEST 2.322" THICK STATIC AIR  
IN-792

## X-RAY DIFFRACTION DATA

SURFACE  
100 hr  
STANDARD SURFACE  
SPINEL,  $a_0 = 0.25 \text{ \AA}$ .  
NiO  
TRI(RUTILE).  $d(110) 53.30 \text{ \AA}$ .  
Cr<sub>2</sub>O<sub>3</sub>  
(Ni,Cr,Fe)TiO<sub>3</sub>  
Ni(W.M.)O, TYPE 1

SPALL  
100 hr  
COLLECTED SPALL  
NiO  
SPINEL,  $a_0 = 0.30 \text{ \AA}$ .  
TRI(RUTILE).  $d(110) 53.30 \text{ \AA}$ .  
Ni(W.M.)O, TYPE 1  
Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

1150°C

1.00hr CYCLES

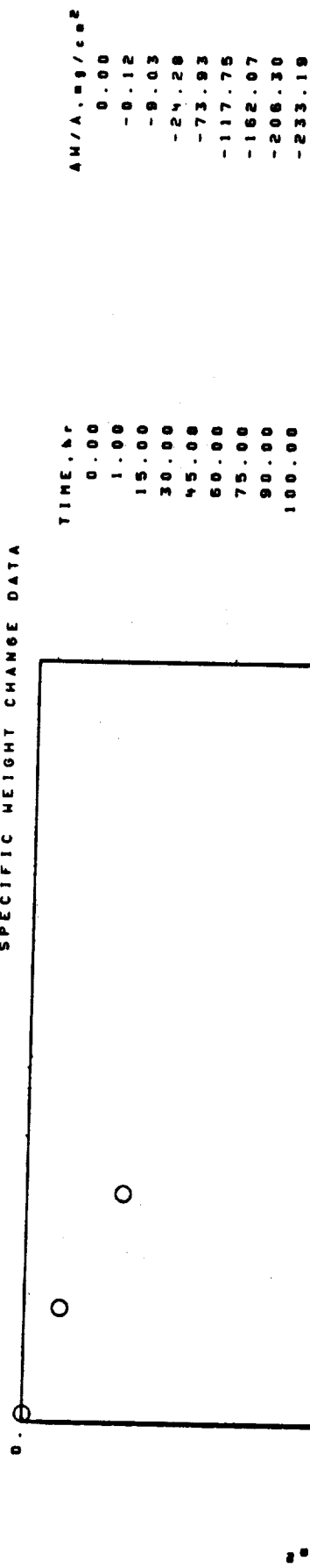
100.00hr TEST

THICK

STATIC AIR

02-04-006-425-4

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-006-425-4  
 IN-792 1150°C 1.00hr CYCLES 100.00hr TEST 2.172 THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NiO	NiO
Cr <sub>2</sub> O <sub>3</sub>	SPINEL, a <sub>0</sub> =8.30A.
TRI(RUTILE).4(110)S3.30A.	Ni(W.Mo)O <sub>4</sub> TYPE 1
SPINEL, a <sub>0</sub> =8.25A.	TRI(RUTILE).4(110)S3.30A.
(Ni.Co.Fe)TiO <sub>3</sub>	
Ni(W.Mo)O <sub>4</sub> TYPE 1	

FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-425-S

IN-792

1150°C

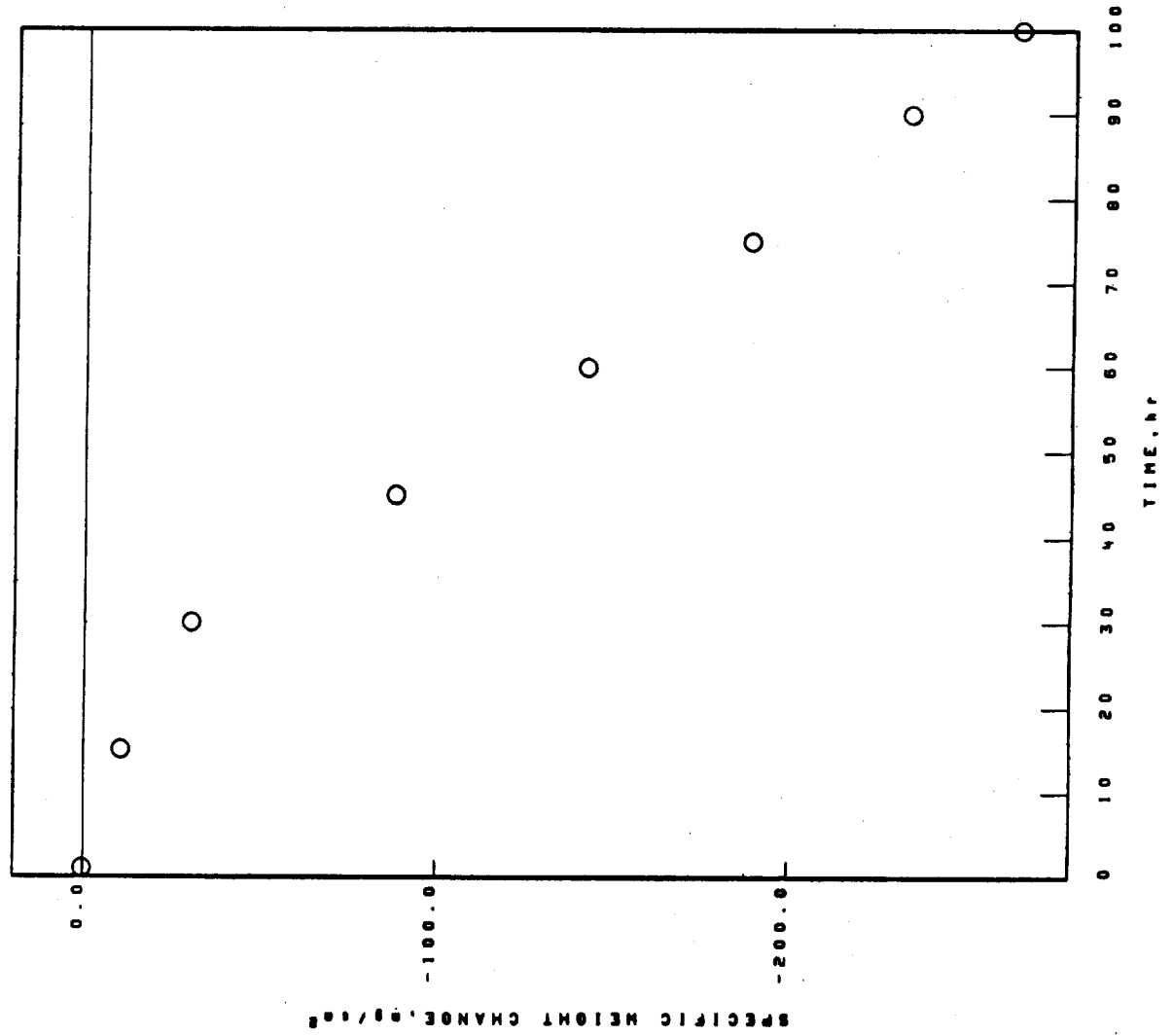
1.00hr CYCLES

100.00hr TEST

2.284mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔN/A, g/cm²  
0.00  
0.23  
-10.50  
-30.33  
-88.16  
-142.40  
-188.48  
-233.47  
-264.49

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.204mm THICK STATIC AIR  
 1M-792

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NI <sub>2</sub> O	NI <sub>2</sub> O
Cr <sub>2</sub> O <sub>3</sub>	SPINEL. 08-08-30A.
TRI(RUTILE). 0(110)53.30A.	NI(M.H.)O <sub>4</sub> TYPE 1
SPINEL. 08-08-25A.	TRI(RUTILE). 0(110)53.30A.
(NI.Co.Fe)TiO <sub>3</sub>	
NI(M.H.)O <sub>4</sub> TYPE 1	

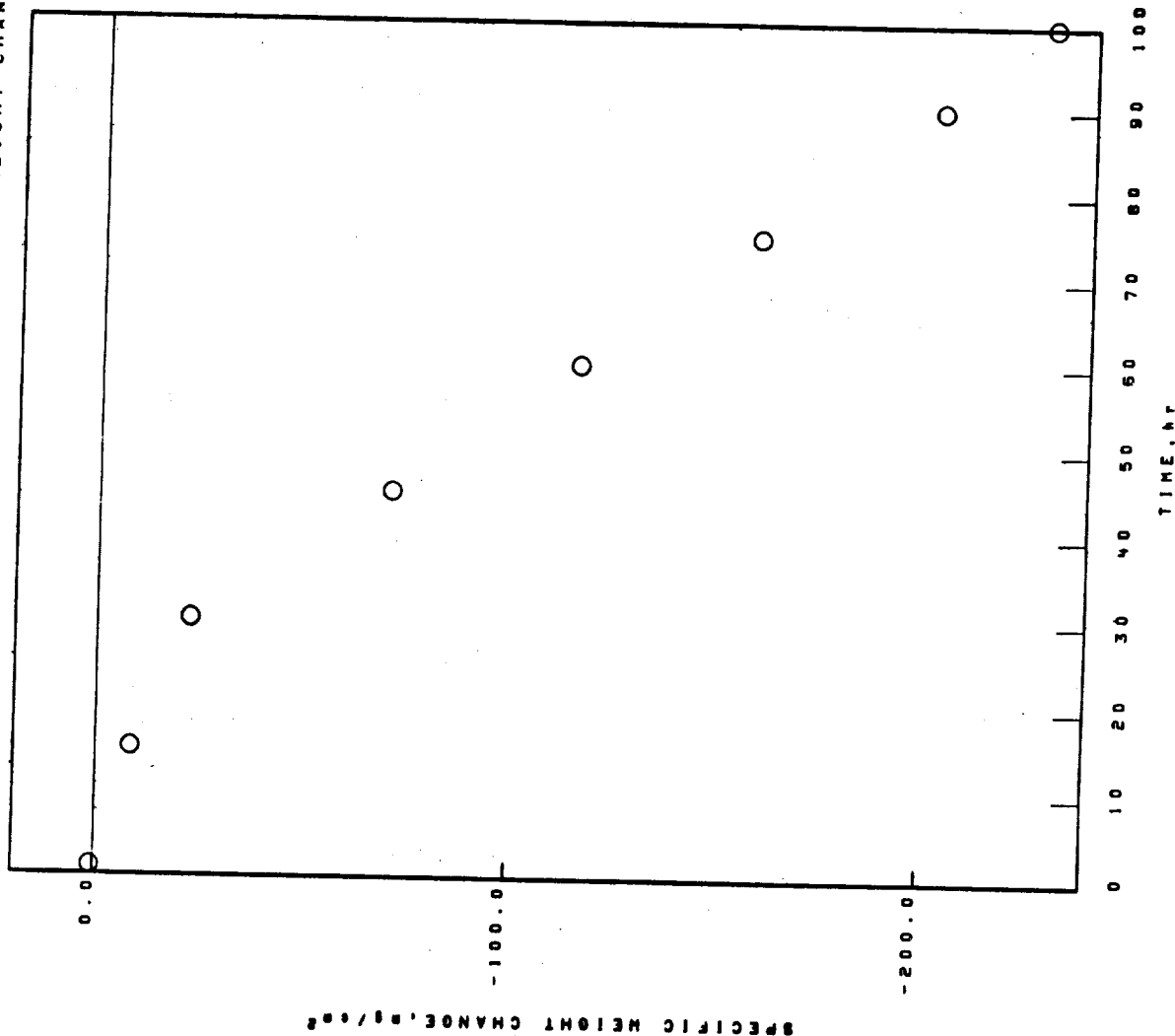
## FACE CENTERED CUBIC MATRIX

# NI BASE IN-792

02-04-006-426-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.272mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, %/cm²  
0.00  
0.72  
-8.50  
-22.50  
-70.82  
-116.03  
-159.38  
-203.04  
-229.65

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

THICK STATIC AIR

2.272

100.00hr TEST

1150°C 1.00hr CYCLES

IN-792

NI BASE

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $\theta_0 = 8.30^\circ$	NIO
NIO	SPINEL, $\theta_0 = 8.25^\circ$
Cr <sub>2</sub> O <sub>3</sub>	TRI(RUTILE), $\lambda(110) \lambda 3.30^\circ$
(Ni,Co,Fe)TiO <sub>3</sub>	Ni(W.Mo)O <sub>4</sub> TYPE I
TRI(RUTILE), $\lambda(110) \lambda 3.30^\circ$	Cr <sub>2</sub> O <sub>3</sub>
Ni(W.Mo)O <sub>4</sub> TYPE I	

FACE CENTERED CUBIC MATRIX

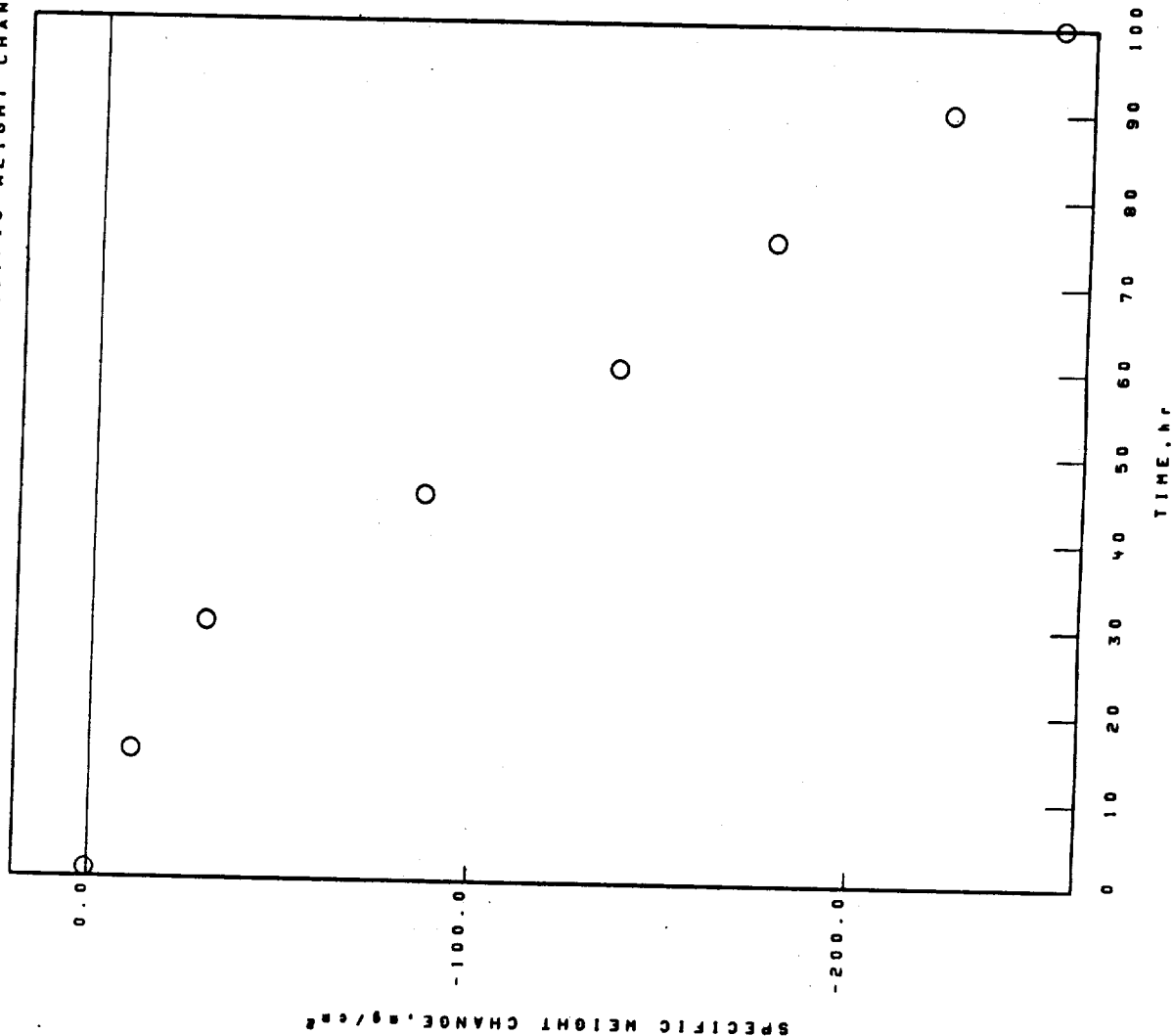
NI BASE  
IN-792

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-426-5

1150°C 1.00hr CYCLES 100.00hr TEST 2.280mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

$\Delta W/A, g/cm^2$   
0.00  
0.55  
-10.95  
-29.95  
-86.59  
-136.99  
-177.51  
-222.96  
-251.41

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

CYCLES

1150°C

100.00hr

1M-792

## X-RAY DIFFRACTION DATA

## SURFACE

100 hr

## STANDARD SURFACE

SPINEL,  $a_0 = 8.30 \text{ \AA}$ .

NiO

Cr<sub>2</sub>O<sub>3</sub>(Ni,Cr,Fe)TiO<sub>3</sub>TRI(RUTILE),  $d(110) \leq 3.30 \text{ \AA}$ .Ni(W,M)O<sub>4</sub> TYPE I

## SPALL

100 hr

## COLLECTED SPALL

NiO

SPINEL,  $a_0 = 8.25 \text{ \AA}$ .TRI(RUTILE),  $d(110) \leq 3.30 \text{ \AA}$ .Ni(W,M)O<sub>4</sub> TYPE ICr<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

NI BASE  
IN-792

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1150°C

1.00hr CYCLES

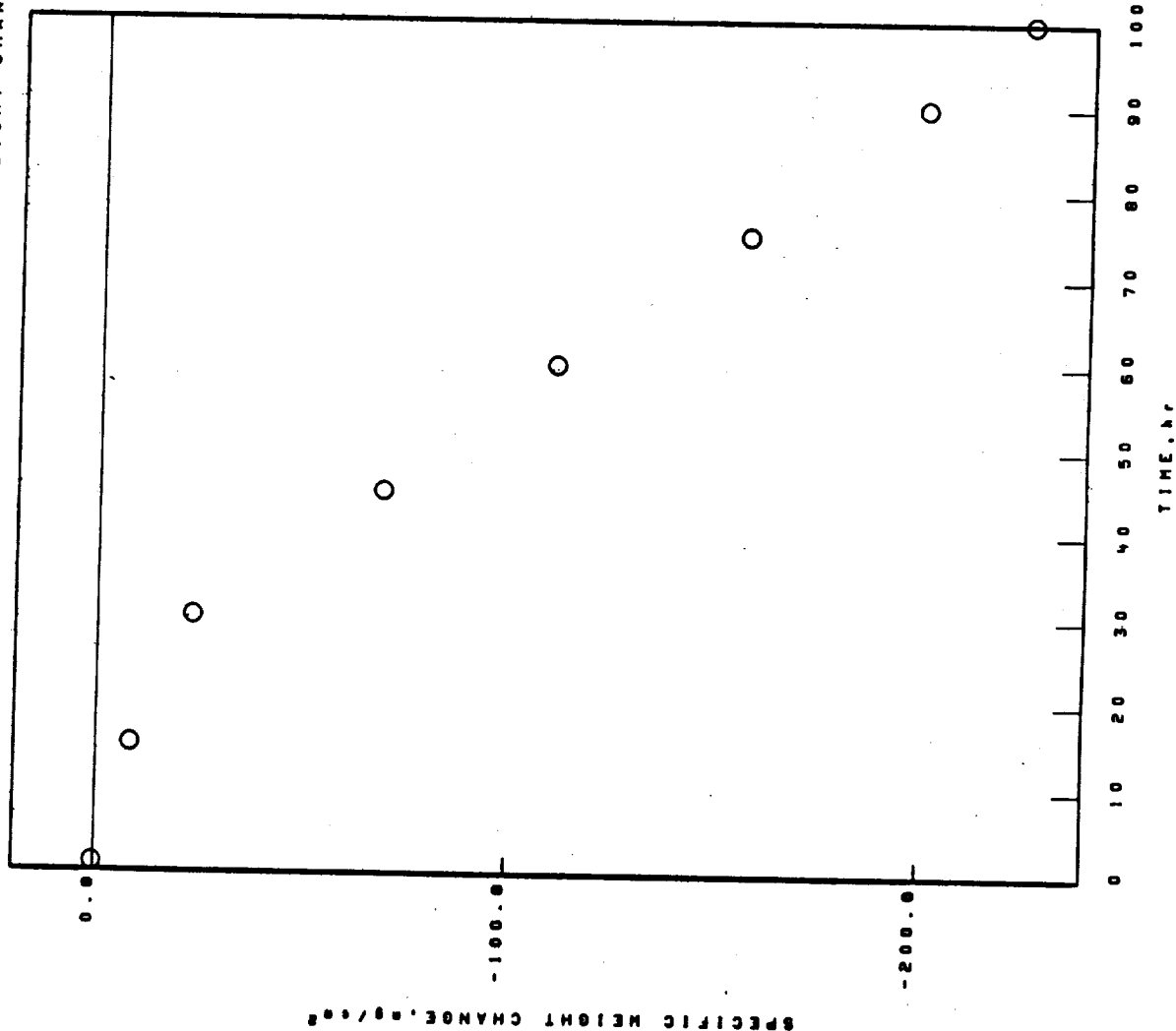
100.00hr TEST

2.250mm THICK

STATIC AIR

02-04-006-428-4

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔH/A, g/g  
0.00  
0.34  
-8.20  
-23.00  
-68.80  
-110.50  
-156.97  
-199.62  
-224.97



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-782 1150°C 1.00hr CYCLES 100.00hr TEST 2.260mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NI <sub>2</sub> O	NI <sub>2</sub> O
SPINEL, $\theta_0=8.30A$ .	SPINEL, $\theta_0=8.30A$ .
Cr <sub>2</sub> O <sub>3</sub>	TRI(RUTILE), 4(110) 13.30A.
TRI(RUTILE), 4(110) 13.30A.	NI(W.M.)O <sub>4</sub> TYPE 1
NI(W.M.)O <sub>4</sub> TYPE 1	Cr <sub>2</sub> O <sub>3</sub>
(NI,Co,Fe)TiO <sub>3</sub>	(NI,Co,Fe)TiO <sub>3</sub>
SPINEL, $\theta_0=8.10A$ .	

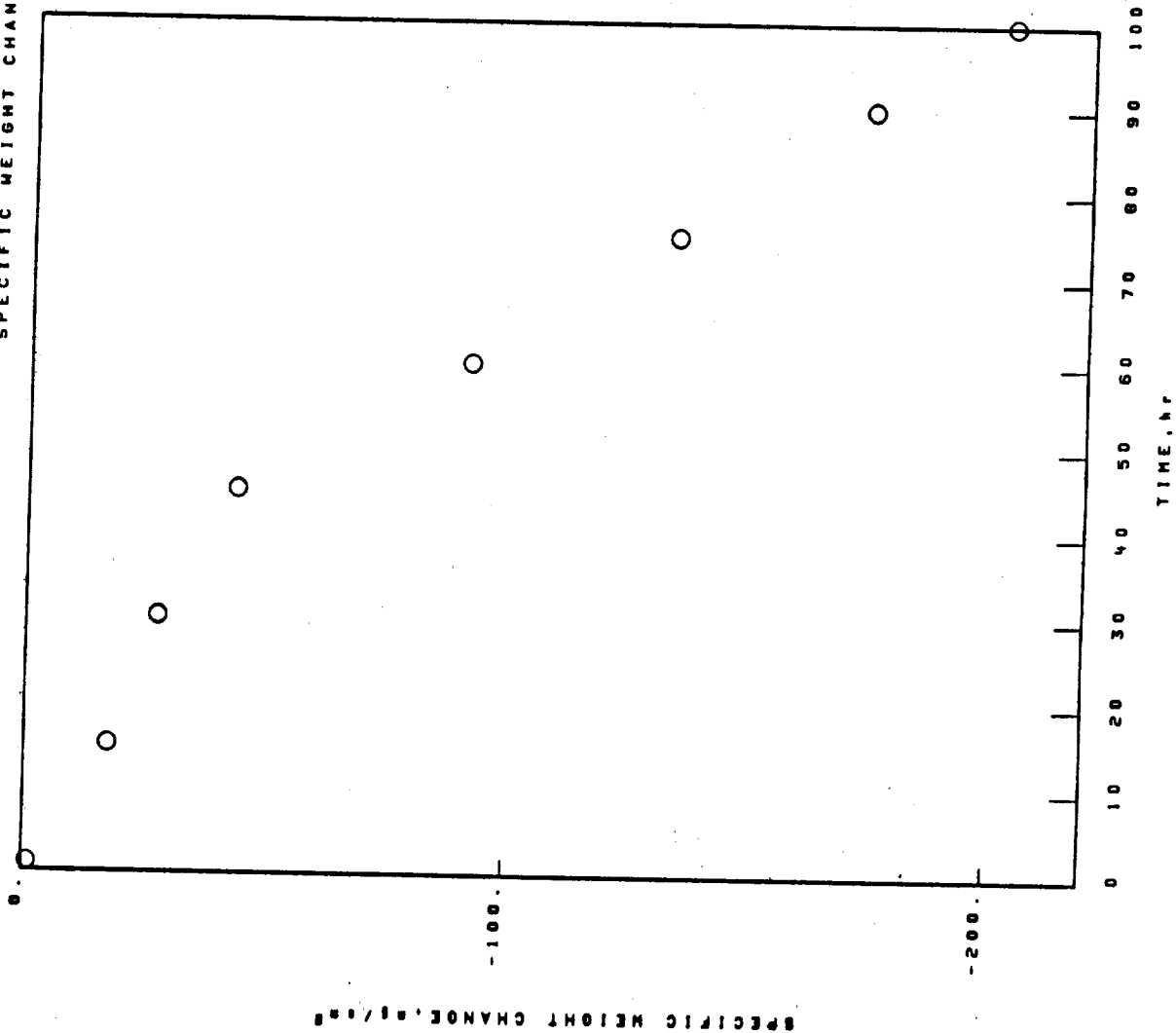
NI BASE  
IM-782

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-470-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

AM/A, g/cm<sup>2</sup>  
0.00  
-1.16  
-17.41  
-27.40  
-43.43  
-81.69  
-134.20  
-174.56  
-203.36

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

THICK STATIC AIR

2.318

TEST

1.00hr CYCLES

1150°C

IN-792

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

TRI(RUTILE).4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>

## SPALL

1 hr

## COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8-25A.

Ni(W.M.)O<sub>4</sub> TYPE 1

TRI(RUTILE).4(110)53.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

100 hr

## COLLECTED SPALL

NiO

SPINEL. 80-8-30A.

Ni(W.M.)O<sub>4</sub> TYPE 1

TRI(RUTILE).4(110)53.30A.

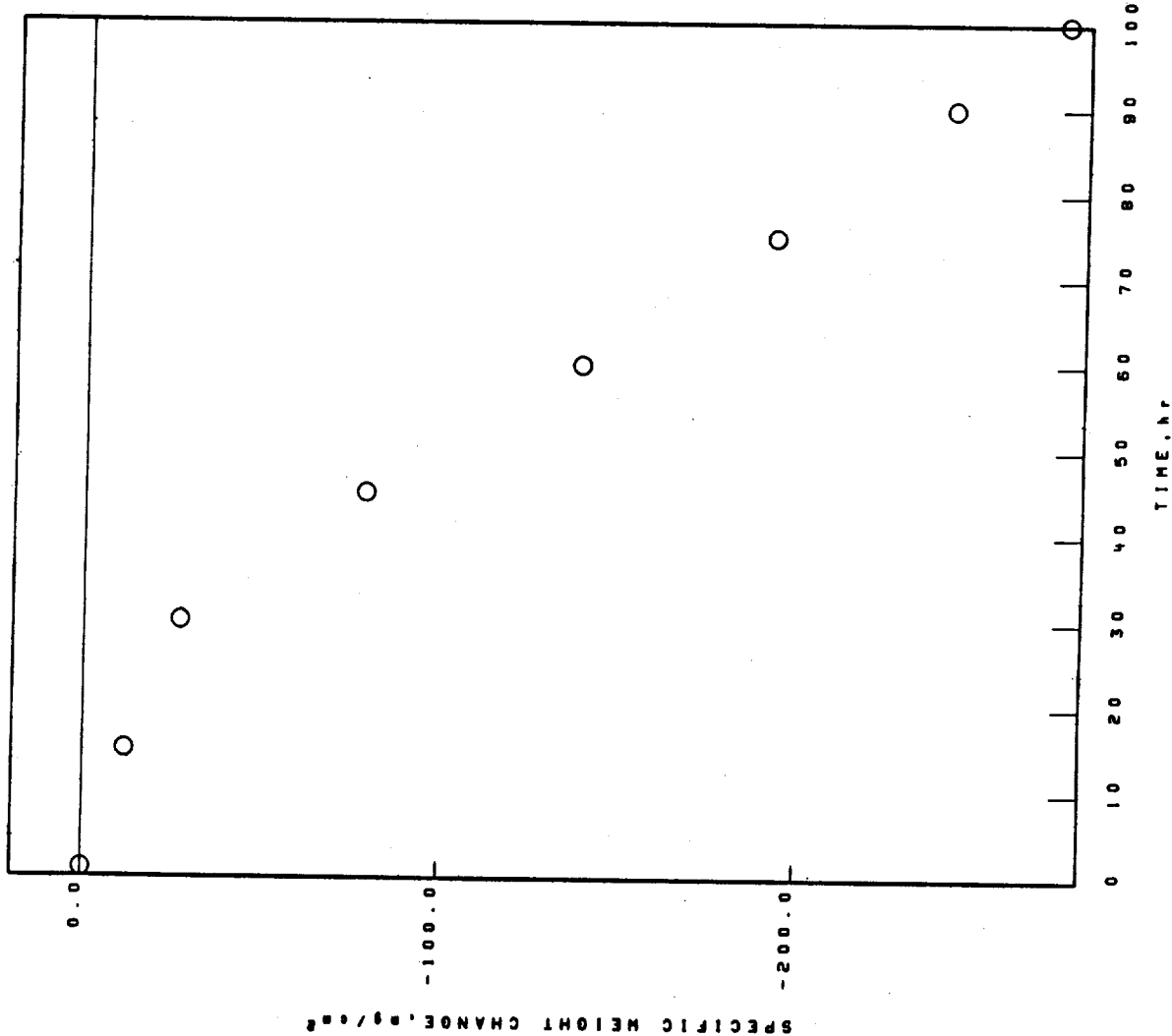
(Ni.Co.Fe)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

# NI BASE IN-792

02-04-006-428-5  
1150°C 1.00hr CYCLES 100.00hr TEST 2.288mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
0.05  
-11.72  
-26.96  
-78.75  
-138.84  
-192.85  
-242.35  
-273.78

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

100.00hr TEST 2.288mm THICK

IM-792

1150°C

## X-RAY DIFFRACTION DATA

## SURFACE

100 hr

## STANDARD SURFACE

NiO

SPINEL,  $\theta_0=8.30A$ .Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O, TYPE 1

(Ni.Co.Fe)TiO<sub>3</sub>SPINEL,  $\theta_0=8.10A$ .

## SPALL

100 hr

## COLLECTED SPALL

NiO

SPINEL,  $\theta_0=8.30A$ .

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O, TYPE 1

Cr<sub>2</sub>O<sub>3</sub>(Ni.Co.Fe)TiO<sub>3</sub>

NI BASE

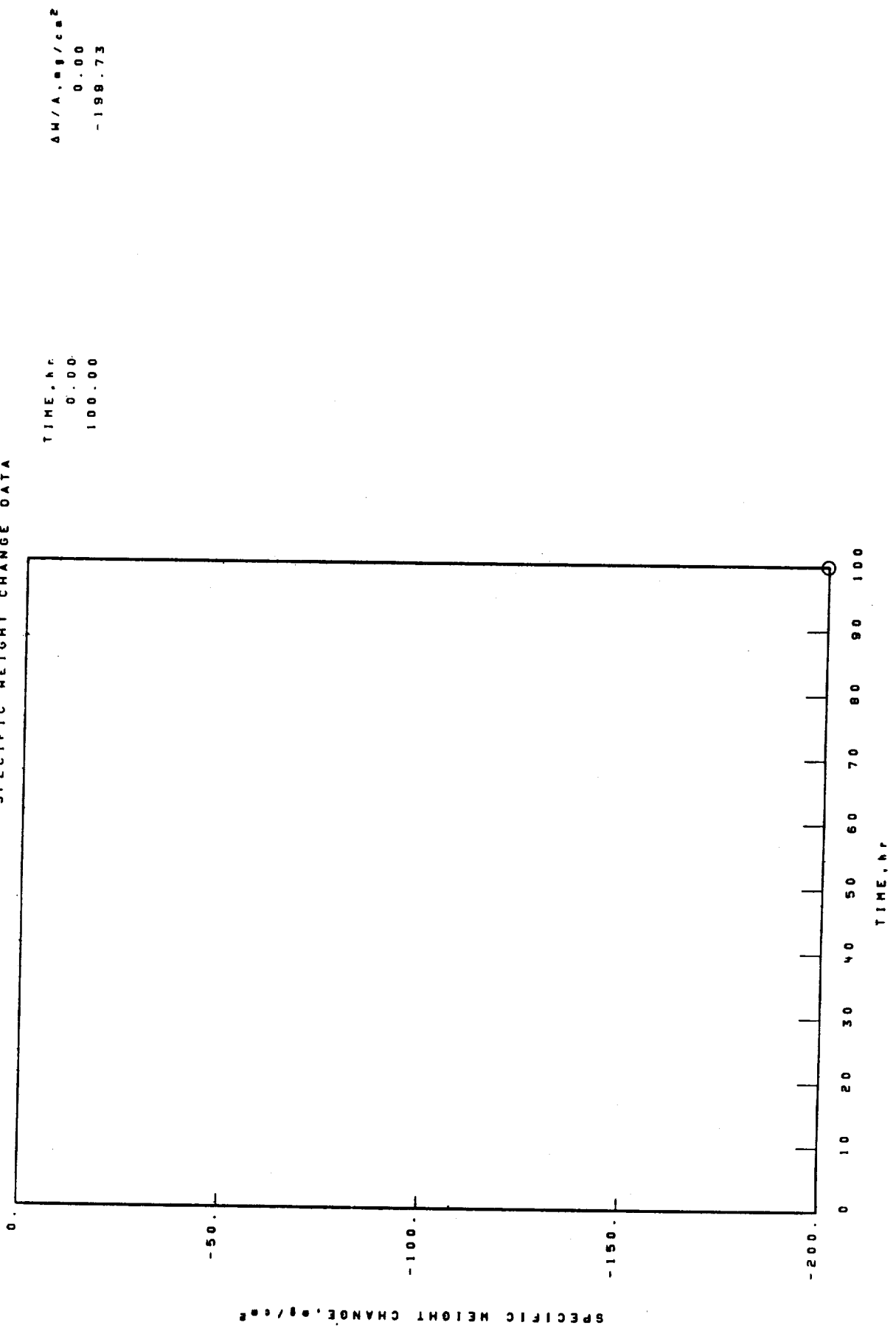
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-431-4

IN-792

1150°C 1.00hr CYCLES 100.00hr TEST 2.276mm THICK STATIC AIR

SPECIFIC HEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 1150°C 1.00hr CYCLES 100.00hr TEST 2.276mm THICK STATIC AIR  
IN-792

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NIO

SPINEL.  $\theta_0=8.25A$ .

TRI(RUTILE),  $4(110)\{3.30A$ .

NI(W.M.)O, TYPE 1

SPINEL.  $\theta_0=8.10A$ .

Cr<sub>2</sub>O<sub>3</sub>

(NI.CO.F.)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NIO

TRI(RUTILE),  $4(110)\{3.30A$ .

SPINEL.  $\theta_0=8.05A$ .

NI(W.M.)O, TYPE 1

SPINEL.  $\theta_0=8.25A$ .

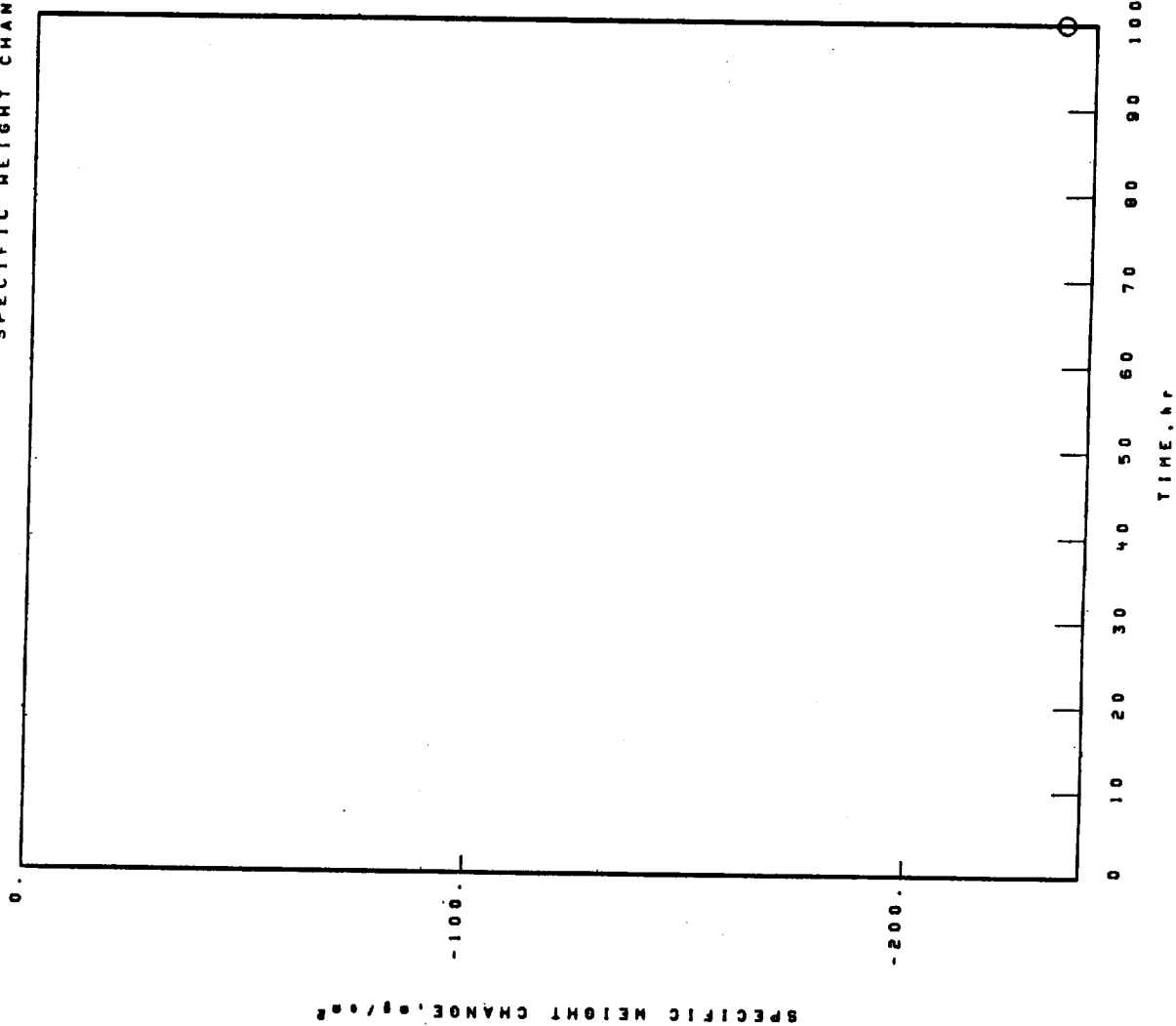
NI BASE  
IM-782

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-431-S

1150°C 1.00hr CYCLES 100.00hr TEST 2.286mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
100.00

ΔW/A, g/cm²  
0.00  
-233.10



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 1150°C 1.00hr CYCLES 100.00hr TEST 2.285mm THICK STATIC AIR  
IN-792

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
SPINEL, $\theta_0=8.25^\circ$ .	SPINEL, $\theta_0=8.25^\circ$ .
TRI(RUTILE), $\lambda(110)\lambda 3.30^\circ$ .	TRI(RUTILE), $\lambda(110)\lambda 3.30^\circ$ .
NI(W.M.)O <sub>4</sub> TYPE 1	NI(W.M.)O <sub>4</sub> TYPE 1
SPINEL, $\theta_0=8.10^\circ$ .	Cr <sub>2</sub> O <sub>3</sub>
Cr <sub>2</sub> O <sub>3</sub>	(NI.Ce.Fe)TiO <sub>3</sub>
(NI.Ce.Fe)TiO <sub>3</sub>	SPINEL, $\theta_0=8.10^\circ$ .

FACE CENTERED CUBIC MATRIX

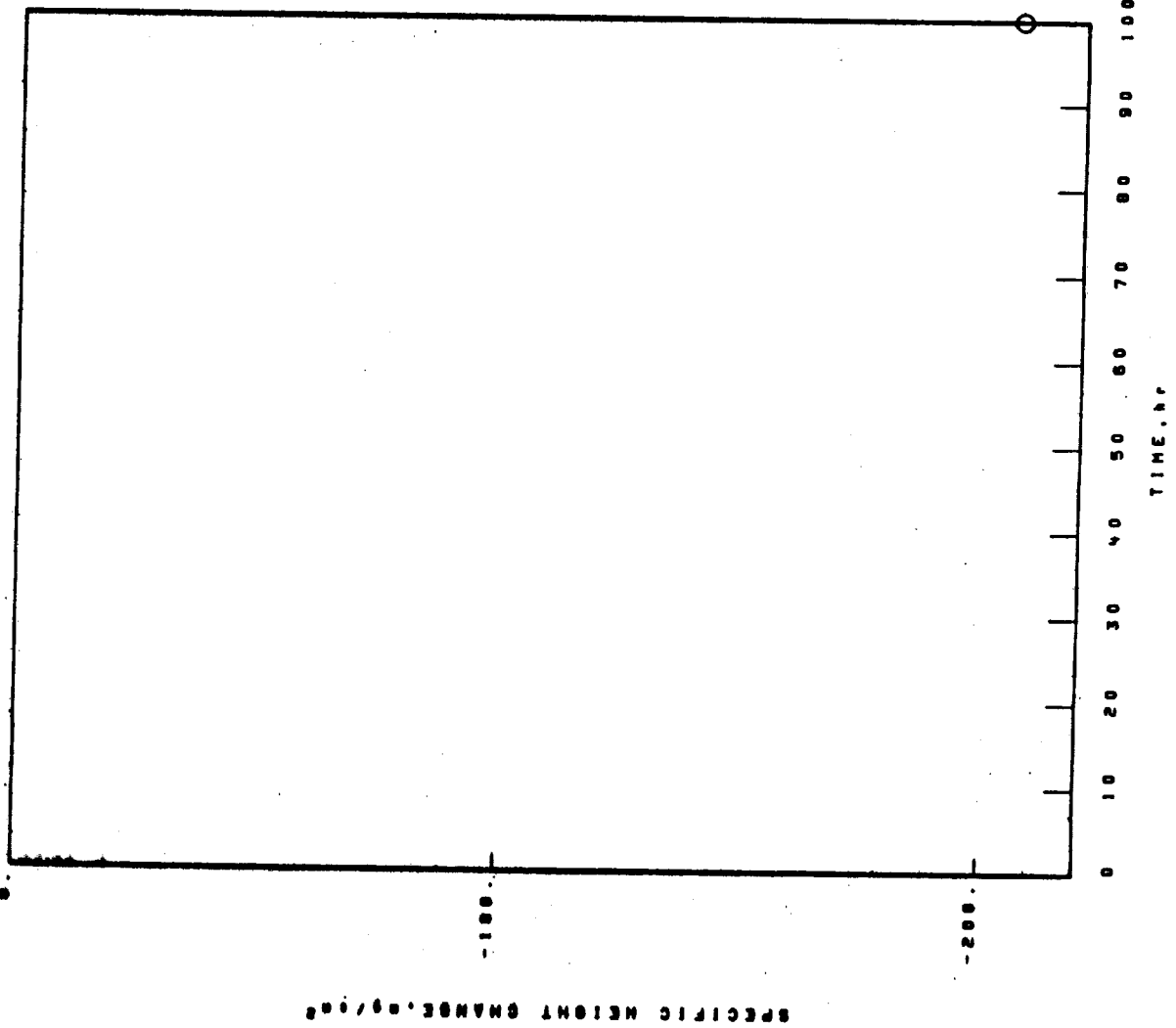
NI BASE  
IM-702

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-432-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.208mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
100.00

AM/A, g/cm<sup>2</sup>  
0.00  
-206.82

NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-006-432-4  
 IN-792                      1150°C                      1.00hr CYCLES                      100.00hr TEST                      2.288mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NI <sub>2</sub> O	NI <sub>2</sub> O
SPINEL, 00-8-30A.	SPINEL, 00-8-30A.
TRI(RUTILE), 4(110)53.30A.	TRI(RUTILE), 4(110)53.30A.
Ni(Mo)O <sub>4</sub> , TYPE 1	(Ni,Co,Fe)TiO <sub>3</sub>
SPINEL, 00-8-10A.	Cr <sub>2</sub> O <sub>3</sub>
(Ni,Co,Fe)TiO <sub>3</sub>	Ni(Mo)O <sub>4</sub> , TYPE 1
Cr <sub>2</sub> O <sub>3</sub>	

FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-432-5

IN-792

1150°C

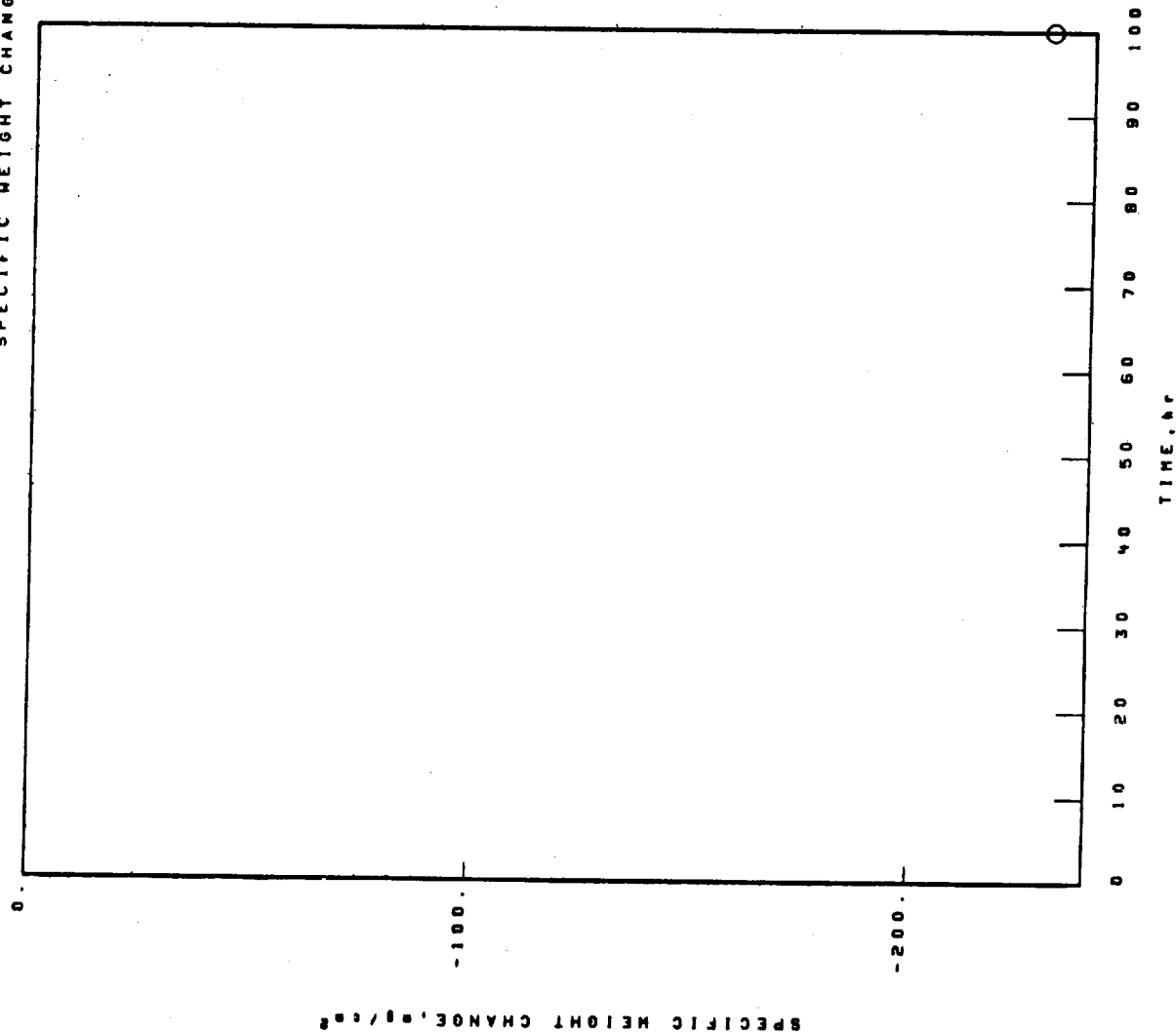
1.00hr CYCLES

100.00hr TEST

2.262mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
100.00

$\Delta W/A, g/cm^2$   
0.00  
-230.43

NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-006-432-5  
 IN-792                      1150°C                      1.00hr CYCLES                      100.00hr TEST                      2.262mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta$ -0.30A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 Ni(W.M.)O, TYPE I  
 SPINEL.  $\theta$ -0.10A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.C.F.)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

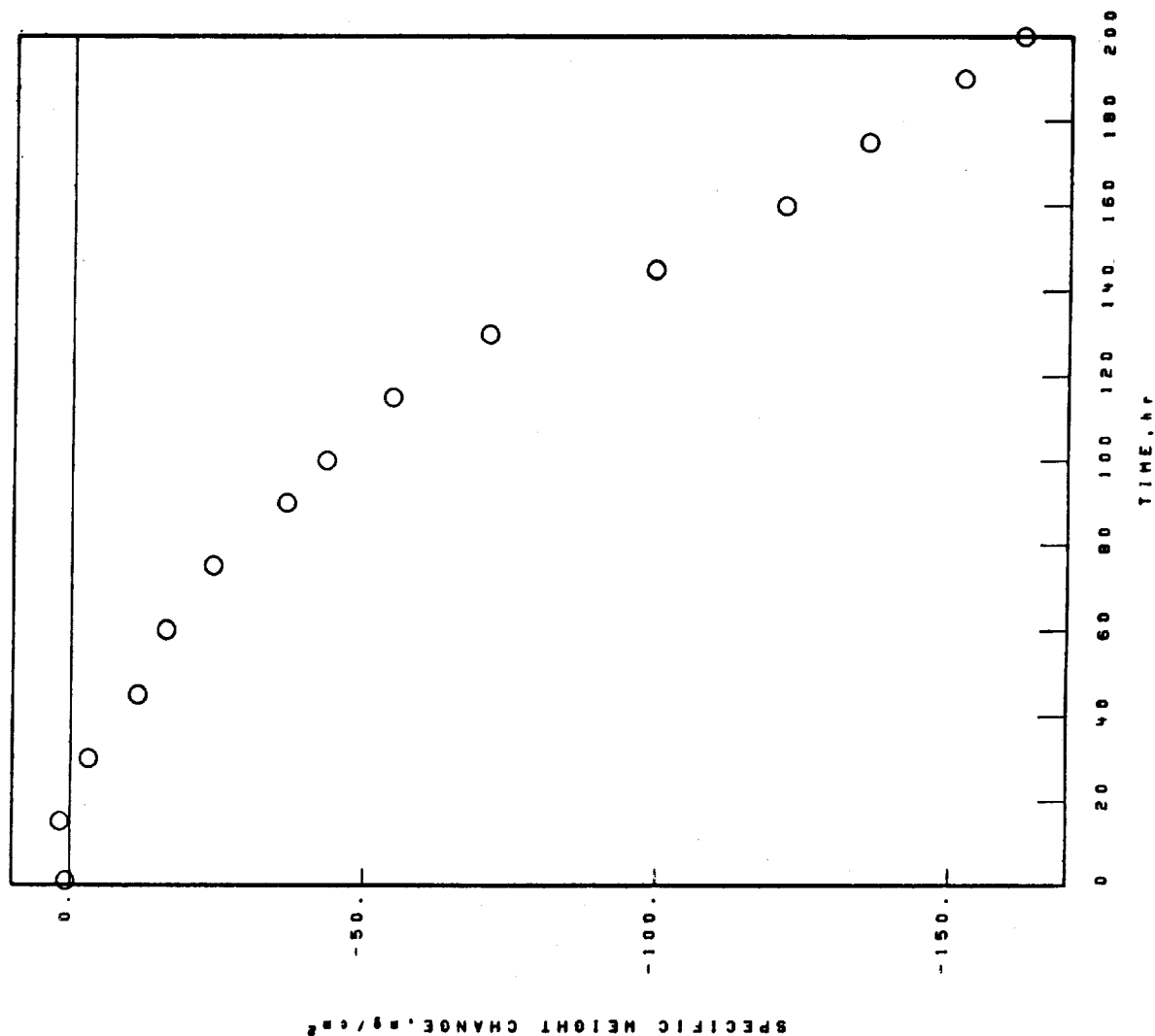
NiO

SPINEL.  $\theta$ -0.30A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 (Ni.C.F.)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(W.M.)O, TYPE I

IN-792

1100°C 1.00hr CYCLES 200.00hr TEST 2.302mm THICK STATIC AIR

SPECIFIC HEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-007-310-2  
 IN-792                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.302mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

NiO

SPINEL,  $a_0 = 8.30 \text{ \AA}$ .

TRI(RUTILE),  $d(110) \{3.30 \text{ \AA}\}$ .

NI(W.M.)O, TYPE 1

Cr<sub>2</sub>O<sub>3</sub>

(NI.Co.Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

200 hr

COLLECTED SPALL

NiO

NI(W.M.)O, TYPE 1

SPINEL,  $a_0 = 8.25 \text{ \AA}$ .

TRI(RUTILE),  $d(110) \{3.30 \text{ \AA}\}$ .

UNKNOWN LINES,  $d$  VALUES

2.73A.

2.69A.

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

1100°C

1.00hr CYCLES

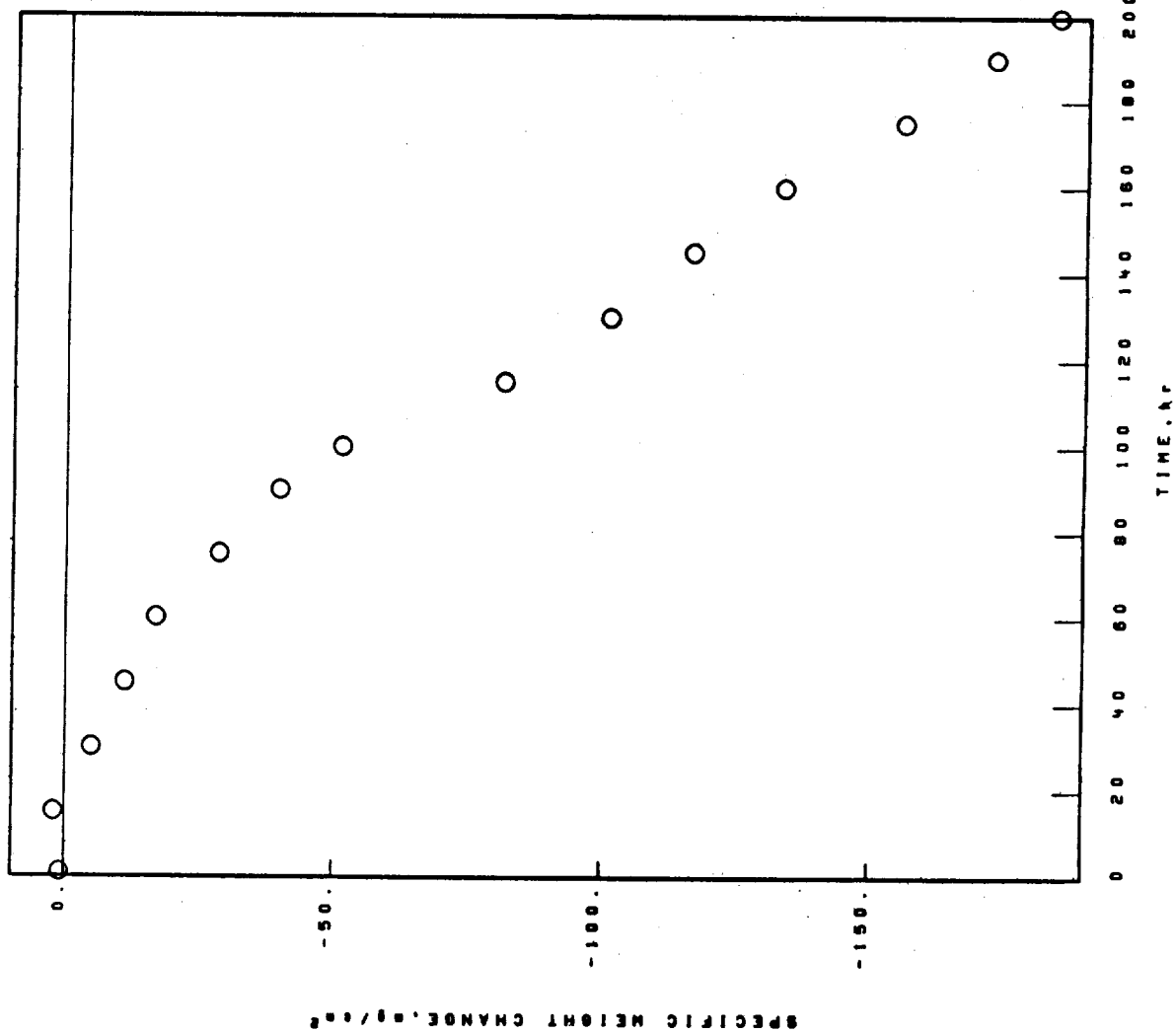
200.00hr TEST

2.315mm THICK

STATIC AIR

02-04-007-326-2

SPECIFIC WEIGHT CHANGE DATA



TIME, hr

ΔW/A, g/cm²



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-326-2  
 IN-792 1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL,  $a_0 = 0.30 \text{ \AA}$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni, Co, Fe)TiO<sub>3</sub>  
 TRI(RUTILE). 4(110) 3.30A.

FACE CENTERED CUBIC MATRIX

SPALL  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL,  $a_0 = 0.30 \text{ \AA}$ .  
 TRI(RUTILE). 4(110) 3.30A.  
 Ni(M, Mn)O, TYPE 1  
 (Ni, Co, Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES,  $\theta$  VALUES  
 3.10A.

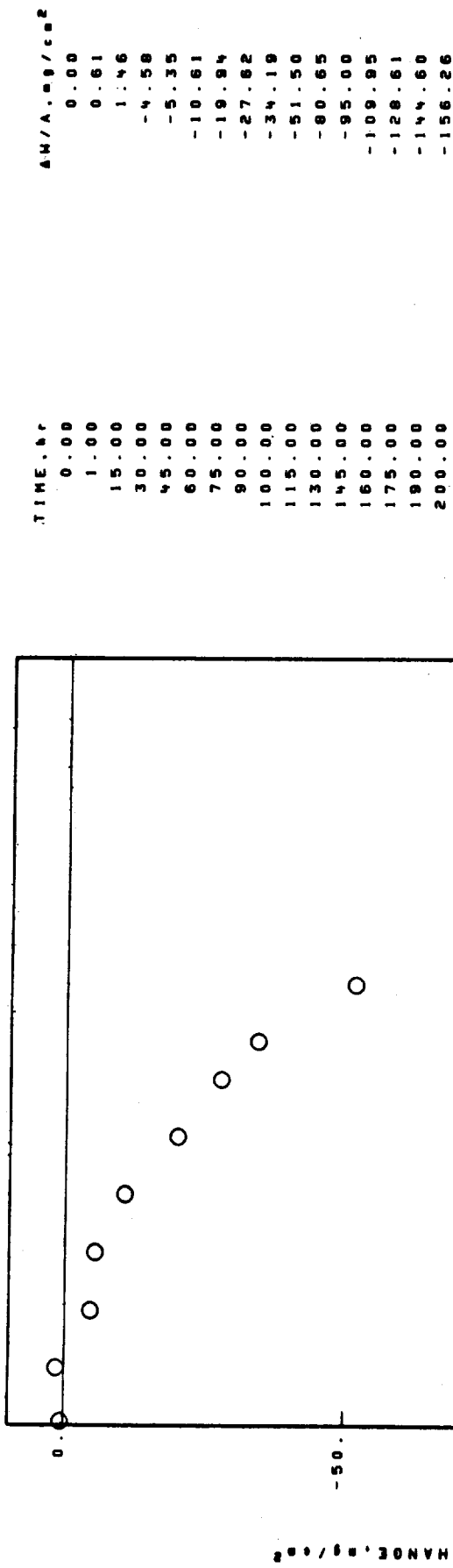
# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-326-5

IN-792

1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-006-326-5  
 IN-792                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.306mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL,  $a_0 = 8.30 \text{ \AA}$ .  
 TRI(RUTILE),  $d(110) \leq 3.30 \text{ \AA}$ .  
 SPINEL,  $a_0 = 8.10 \text{ \AA}$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Co,F)TiO<sub>3</sub>

SPALL  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL,  $a_0 = 8.30 \text{ \AA}$ .  
 Ni(Mo)O<sub>4</sub> TYPE 1  
 TRI(RUTILE),  $d(110) \leq 3.30 \text{ \AA}$ .  
 Ni(Mo)O<sub>4</sub> TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES,  $d$  VALUES  
 2.81 Å.  
 2.78 Å.

NI BASE

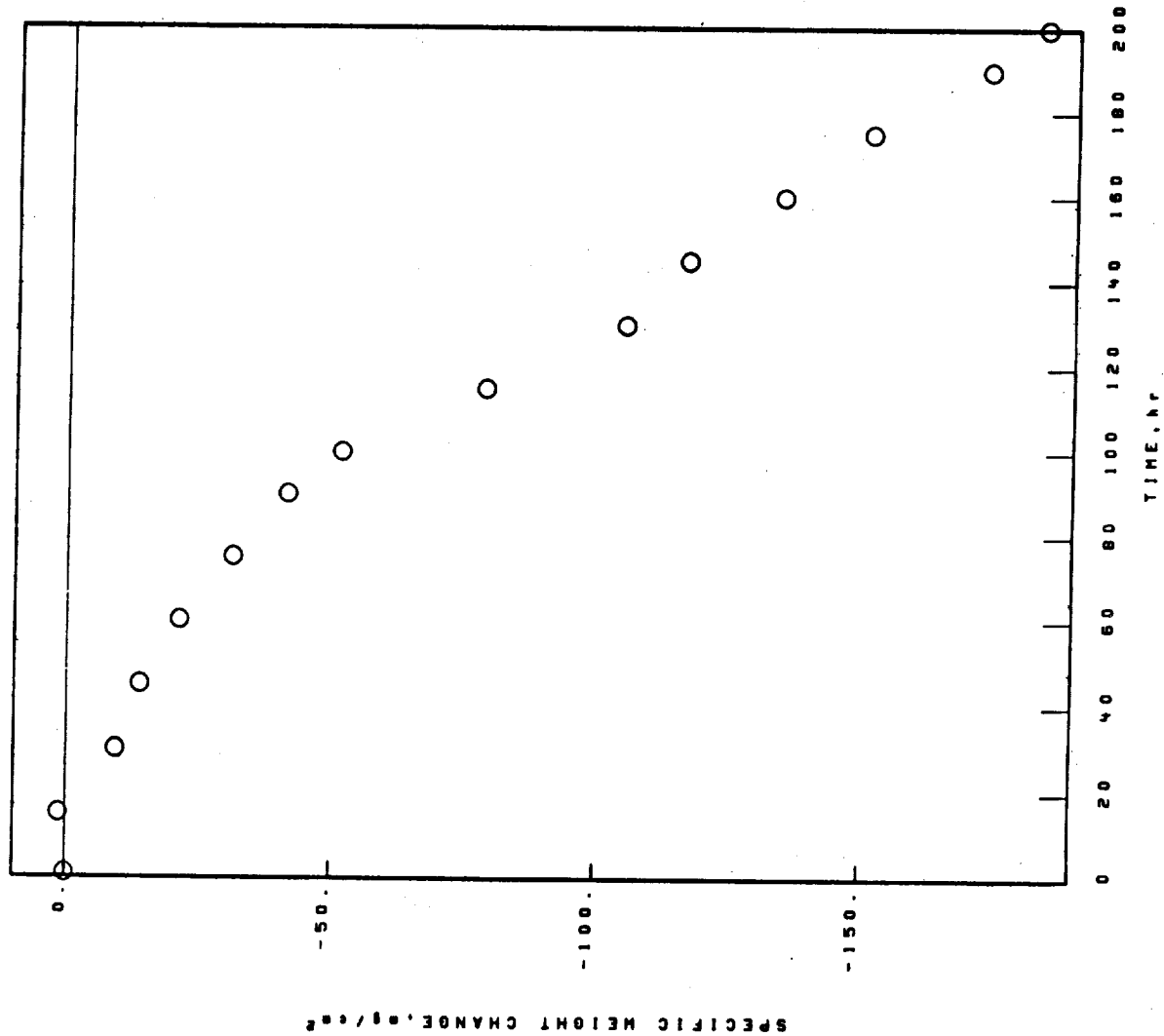
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-007-336-5

IN-792

1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.00
15.00	0.00
30.00	1.36
45.00	-9.31
60.00	-13.80
75.00	-21.27
90.00	-31.24
100.00	-41.50
115.00	-51.69
130.00	-78.81
145.00	-105.17
160.00	-116.84
175.00	-134.69
190.00	-151.17
200.00	-173.42

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-792 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

200 hr

## STANDARD SURFACE

NiO

SPINEL, 99-8-30A.

TRI(RUTILE), 4(110)53-30A.

Cr<sub>2</sub>O<sub>3</sub>(Ni,Co,Fe)TiO<sub>3</sub>

TRI(RUTILE), 4(110)53-30A.

Ni(W.M.)O, TYPE 2

## SPALL

200 hr

## COLLECTED SPALL

NiO

SPINEL, 99-8-30A.

Ni(W.M.)O, TYPE 1

TRI(RUTILE), 4(110)53-30A.

## FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

1100°C

1.00hr CYCLES

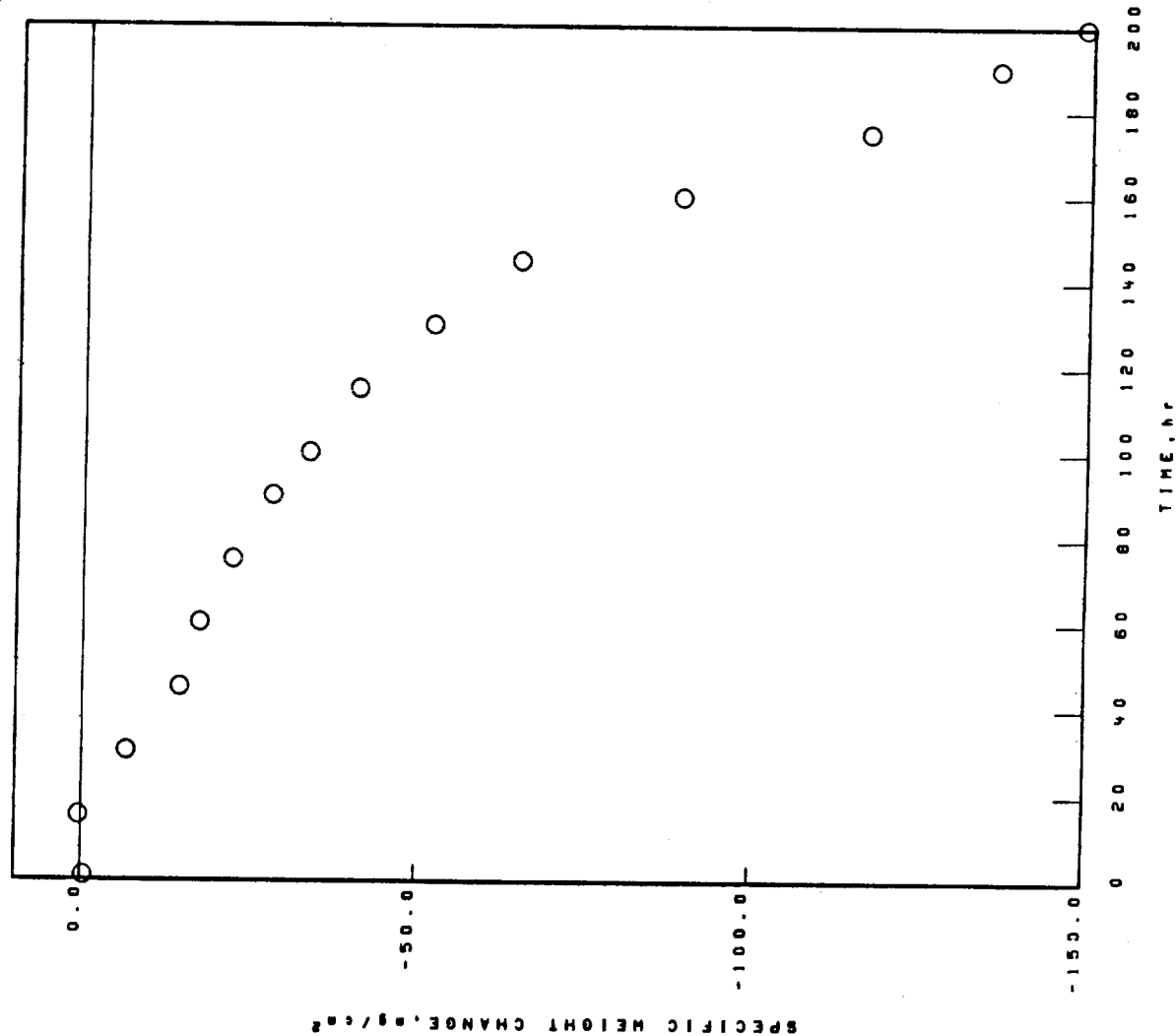
200.00hr TEST

2.316mm THICK

STATIC AIR

02-04-006-411-8

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-0.43
15.00	0.36
30.00	-6.66
45.00	-14.58
60.00	-17.44
75.00	-22.28
90.00	-28.19
100.00	-33.54
115.00	-40.93
130.00	-52.01
145.00	-64.97
160.00	-88.84
175.00	-116.81
190.00	-136.06
200.00	-148.80

NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-006-411-6  
 IN-792                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.316mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL,  $a_0 = 8.25 \text{ \AA}$ .  
 (Ni,Co,Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE),  $d(110) 53.30 \text{ \AA}$ .  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL

200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL,  $a_0 = 8.30 \text{ \AA}$ .  
 Ni(W,Mn)O<sub>4</sub> TYPE I  
 TRI(RUTILE),  $d(110) 53.30 \text{ \AA}$ .  
 Cr<sub>2</sub>O<sub>3</sub>

NI BASE

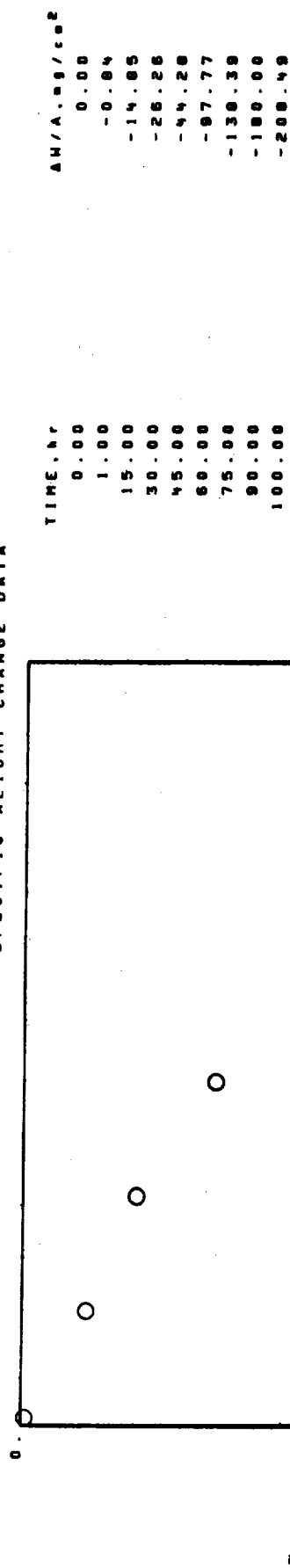
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-006-412-6

IN-792

1100°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
IN-792 1100°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NiO	NiO
SPINEL, $a_0 = 8.30 \text{ \AA}$ .	SPINEL, $a_0 = 8.30 \text{ \AA}$ .
Cr <sub>2</sub> O <sub>3</sub>	TRI(RUTILE), $d(110) \leq 3.30 \text{ \AA}$ .
TRI(RUTILE), $d(110) \leq 3.30 \text{ \AA}$ .	Ni(W.M.)O <sub>4</sub> TYPE 1
(Ni,Co,Fe)TiO <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES, $d$ VALUES
	4.67 \AA.
	2.69 \AA.
	2.02 \AA.

NI BASE

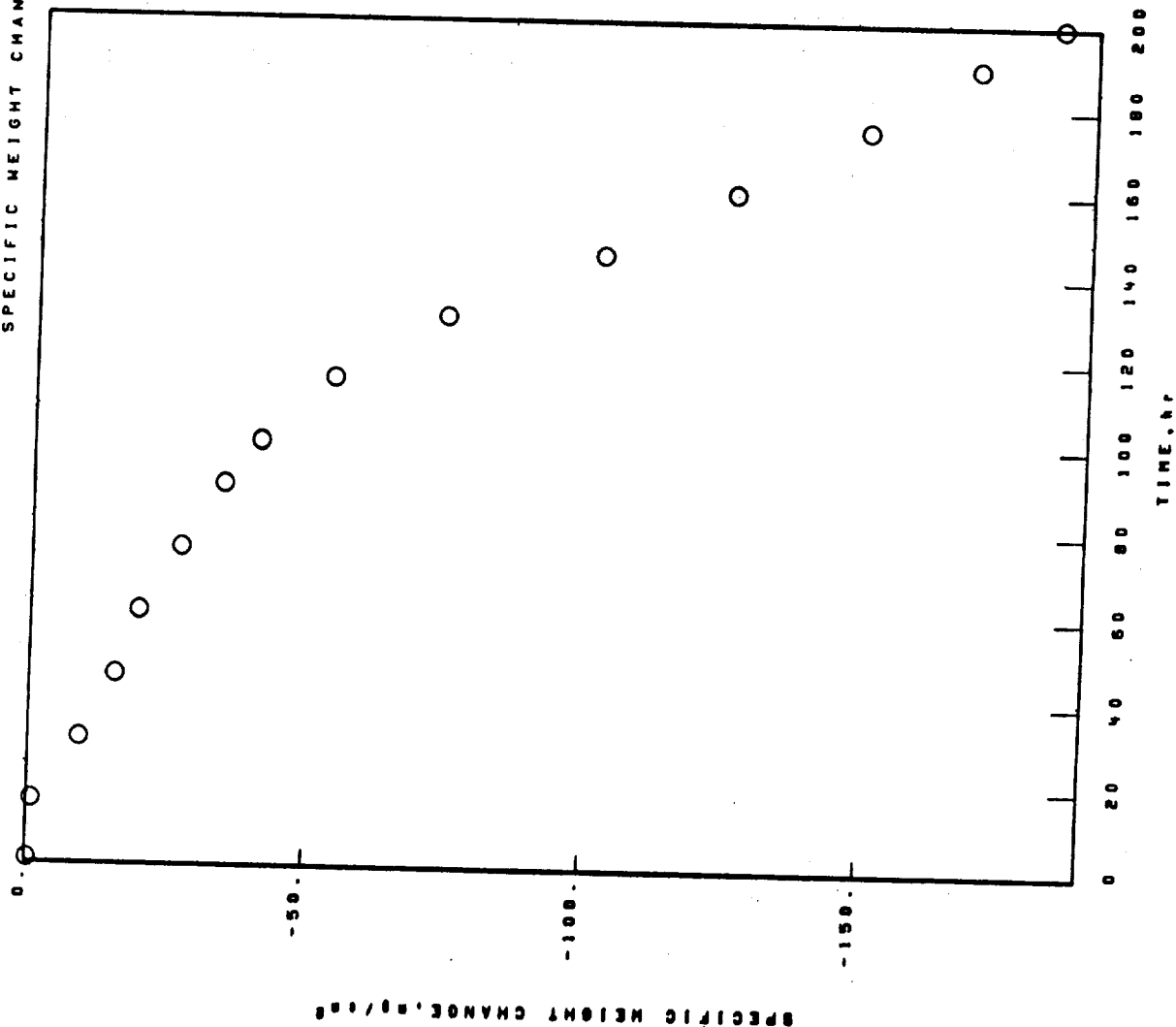
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

02-04-006-469-4

1100°C 1.00hr CYCLES 200.00hr TEST 2.308mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cm²  
0.00  
-0.39  
-0.83  
-9.24  
-15.47  
-19.52  
-26.82  
-34.38  
-40.78  
-53.84  
-73.90  
-101.92  
-125.45  
-149.10  
-160.74  
-163.62

X-RAY DIFFRACTION DATA

SURFACE  
1 hr  
STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.  
TRI(RUTILE).4(110)53.30A.  
FACE CENTERED CUBIC MATRIX  
100 hr  
STANDARD SURFACE  
NiO  
SPINEL. 00-0.10A.  
SPINEL. 00-0.30A.  
TRI(RUTILE).4(110)53.30A.  
TRI(RUTILE).4(110)53.30A.  
Cr<sub>2</sub>O<sub>3</sub>  
FACE CENTERED CUBIC MATRIX  
200 hr  
STANDARD SURFACE  
NiO  
SPINEL. 00-0.25A.  
Cr<sub>2</sub>O<sub>3</sub>  
(Ni.Co.Fe)TiO<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.  
FACE CENTERED CUBIC MATRIX

SPALL  
1 hr  
COLLECTED SPALL  
NiO  
SPINEL. 00-0.35A.  
SPINEL. 00-0.25A.  
TRI(RUTILE).4(110)53.30A.  
100 hr  
COLLECTED SPALL  
NiO  
SPINEL. 00-0.30A.  
Ni(M.Mo)O, TYPE 1  
TRI(RUTILE).4(110)53.30A.  
Cr<sub>2</sub>O<sub>3</sub>  
200 hr  
COLLECTED SPALL  
NiO  
SPINEL. 00-0.25A.  
TRI(RUTILE).4(110)53.30A.  
Ni(M.Mo)O, TYPE 1

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792

1100°C

1.00hr CYCLES

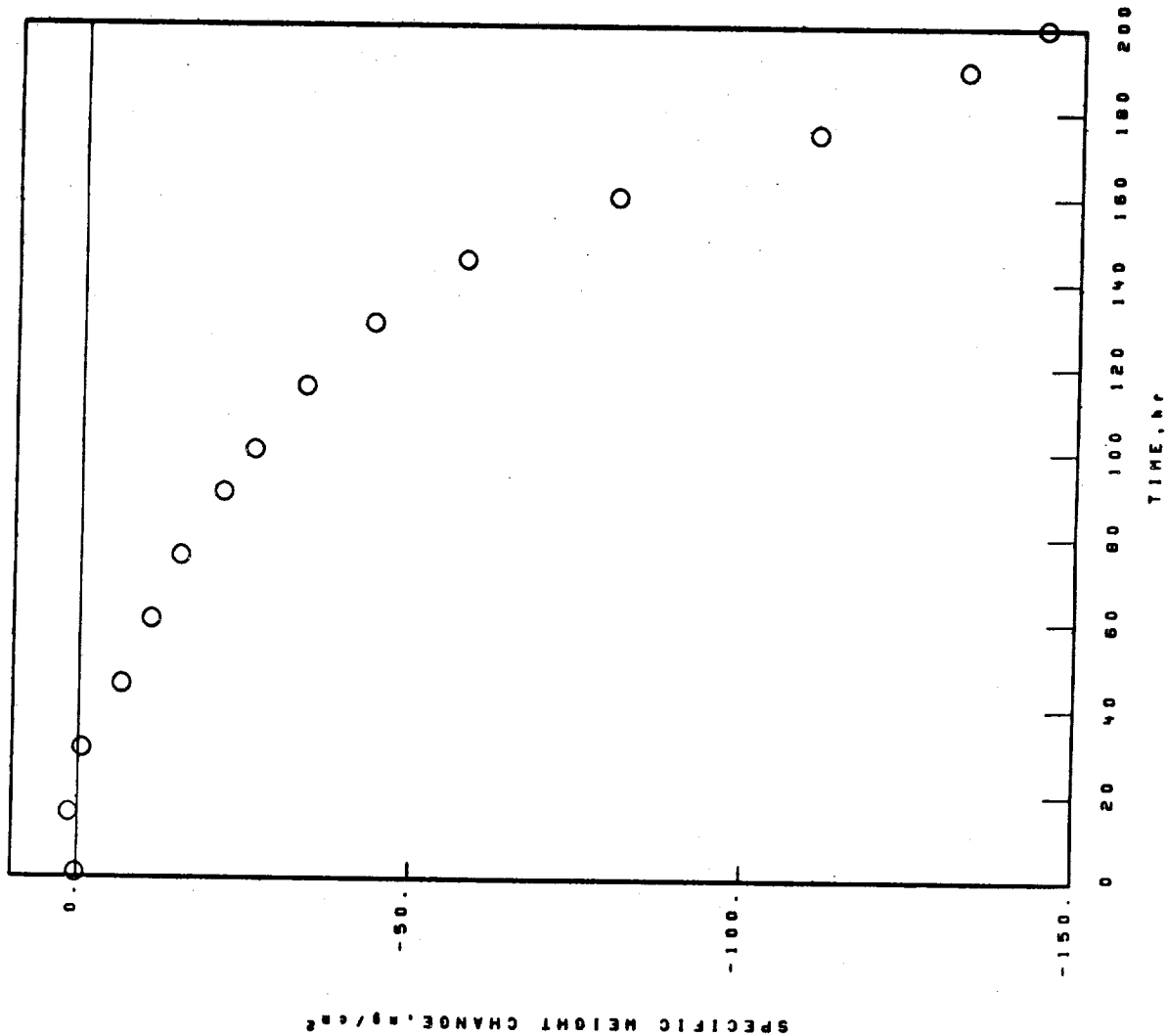
200.00hr TEST

2.312mm THICK

STATIC AIR

02-04-006-657-5

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-792 1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.  
TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NI<sub>2</sub>O  
SPINEL. 80-8.10A.  
TRI(RUTILE).4(110)53.30A.  
SPINEL. 80-8.25A.  
Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NI<sub>2</sub>O  
SPINEL. 80-8.25A.  
Ni(M.M.)O<sub>4</sub> TYPE I  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NI<sub>2</sub>O  
SPINEL. 80-8.25A.  
TRI(RUTILE).4(110)53.30A.

200 hr

COLLECTED SPALL

NI<sub>2</sub>O  
SPINEL. 80-8.25A.  
Ni(M.M.)O<sub>4</sub> TYPE I  
TRI(RUTILE).4(110)53.30A.

# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

IN-939

1150°C

1.00hr CYCLES

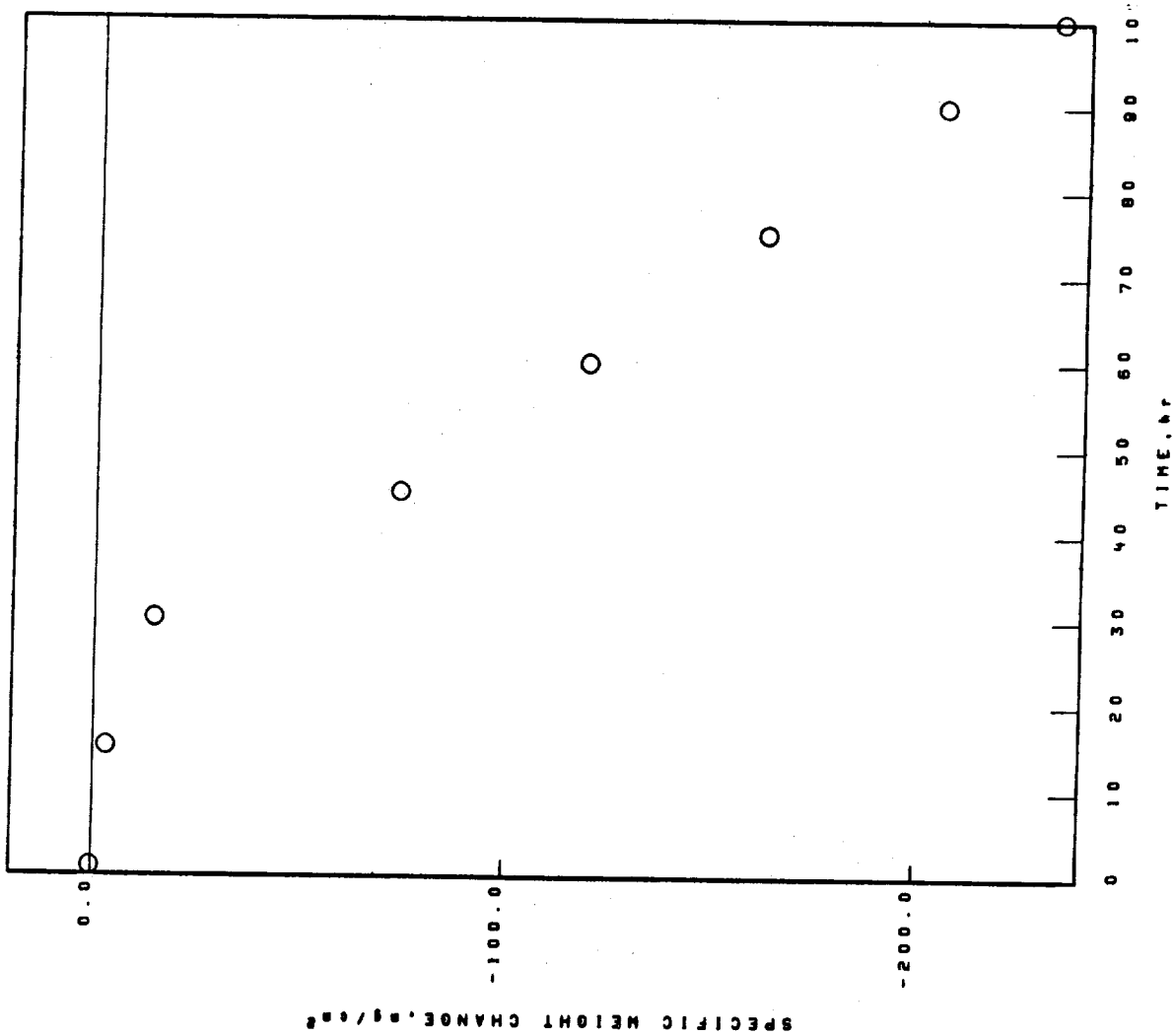
100.00hr TEST

2.310mm THICK

STATIC AIR(SMP)

02-04-031-328-3

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.43
15.00	-3.14
30.00	-14.44
45.00	-73.87
60.00	-119.21
75.00	-161.99
90.00	-205.15
100.00	-233.19

NI BASE  
 IN-939  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR(SMP)  
 02-04-031-328-3

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
Cr <sub>2</sub> O <sub>3</sub>	SPINEL, $\theta_0$ -8.30A.
SPINEL, $\theta_0$ -8.30A.	Cr <sub>2</sub> O <sub>3</sub>
TRI(RUTILE), $\theta_0$ (110)13.30A.	TRI(RUTILE), $\theta_0$ (110)13.
	SPINEL, $\theta_0$ -8.10A.
UNKNOWN LINES, 4 VALUES	
2.81A.	

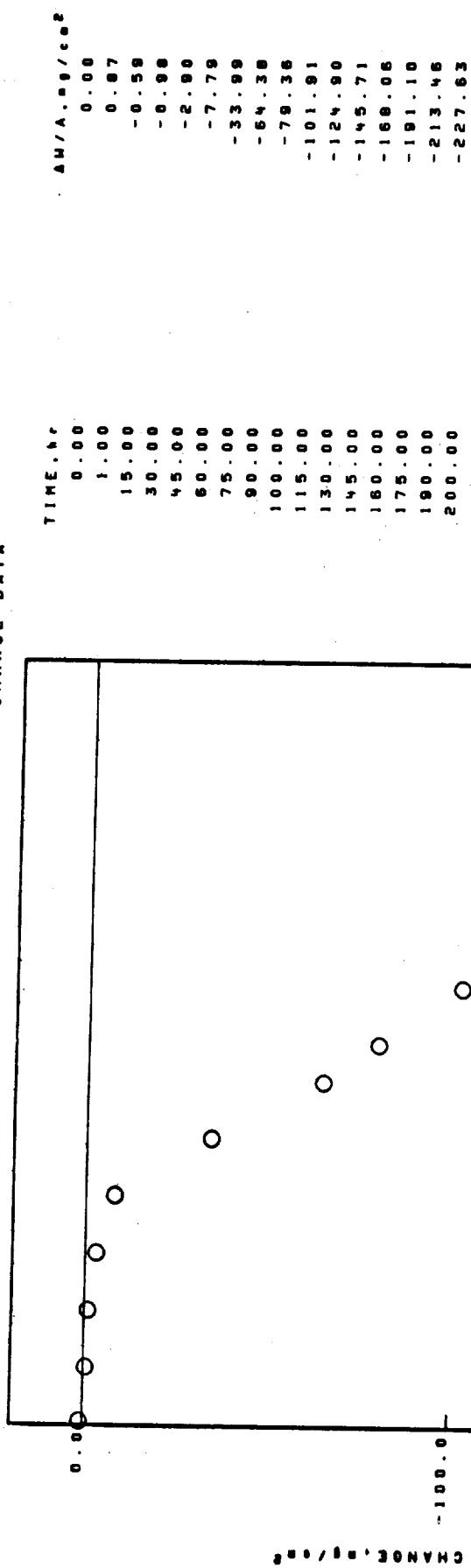
FACE CENTERED CUBIC MATRIX

# WT BASE IN-939 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-031-327-3

1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 IN-939 1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

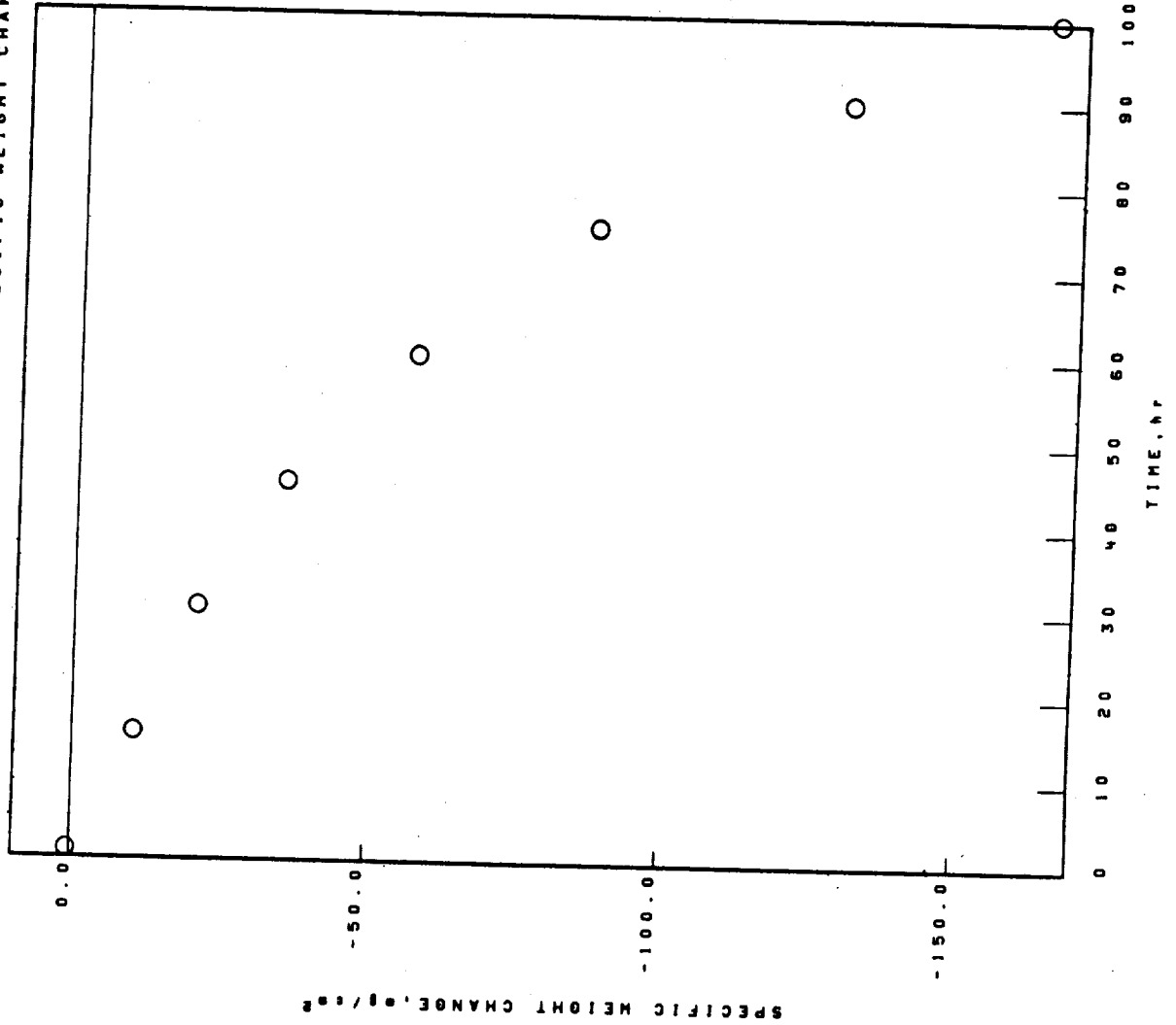
SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
NI O	NI O
SPINEL, $\theta_0=8.30A$ .	SPINEL, $\theta_0=8.30A$ .
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
TRI(RUTILE), $\theta_0=8.30A$ .	TRI(RUTILE), $\theta_0=8.30A$ .
	SPINEL, $\theta_0=8.05A$ .
FACE CENTERED CUBIC MATRIX	

NI BASE  
MAR-M-200

02-04-000-392-1

1150°C 1.00hr CYCLES 100.00hr TEST 2.254mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.50  
-10.43  
-20.91  
-35.65  
-57.34  
-87.55  
-130.14  
-165.20

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.254mm

TEST 100.00hr

1150°C 1.00hr CYCLES

MAR-M-200

X-RAY DIFFRACTION DATA

SURFACE

45 hr

STANDARD SURFACE

SPINEL.  $\theta$ -8.10A.

NIO

NI(W.M.)O<sub>4</sub> TYPE I

SPINEL.  $\theta$ -8.25A.

TRI(RUTILE).  $\delta$ (110)  $\delta$ 3.30A.

SPALL

45 hr

COLLECTED SPALL

NIO

NI(W.M.)O<sub>4</sub> TYPE I

SPINEL.  $\theta$ -8.25A.

TRI(RUTILE).  $\delta$ (110)  $\delta$ 3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NIO

NI(W.M.)O<sub>4</sub> TYPE I

SPINEL.  $\theta$ -8.25A.

TRI(RUTILE).  $\delta$ (110)  $\delta$ 3.30A.

SPINEL.  $\theta$ -8.10A.

FACE CENTERED CUBIC MATRIX

100 hr

COLLECTED SPALL

NIO

NI(W.M.)O<sub>4</sub> TYPE I

SPINEL.  $\theta$ -8.25A.

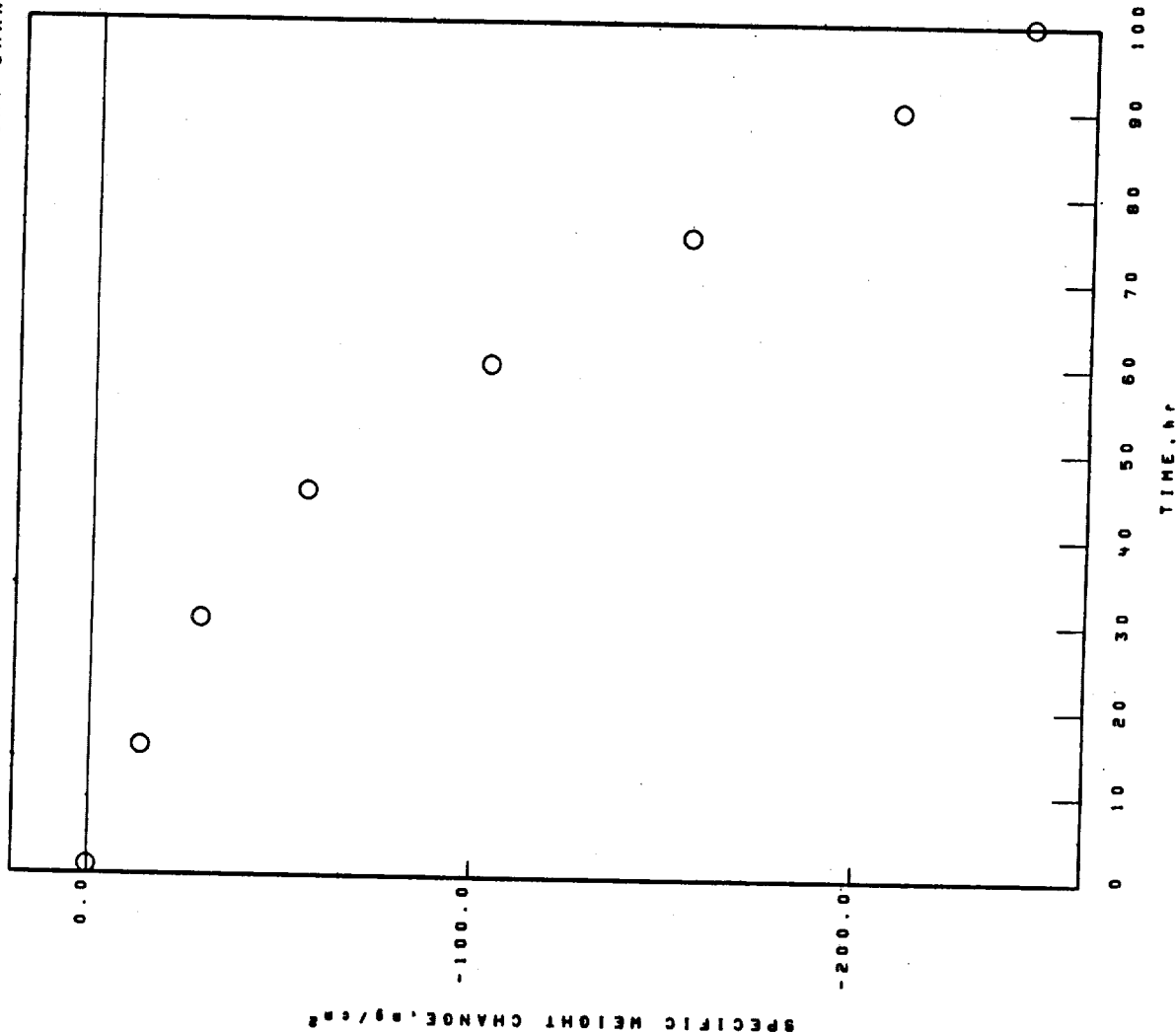
TRI(RUTILE).  $\delta$ (110)  $\delta$ 3.30A.

# NI BASE MAR-M-200

02-04-008-392-2

1150°C 1.00hr CYCLES 100.00hr TEST 2.270mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
0.10  
-13.35  
-28.49  
-55.89  
-103.19  
-155.03  
-209.34  
-243.31

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK 2.270mm

TEST 100.00hr

CYCLES 1.00hr

1150°C

MAR-M-200

## X-RAY DIFFRACTION DATA

## SURFACE

45 hr

## STANDARD SURFACE

NiO

SPINEL.  $\theta$ -8.10A.Ni(M.M.)O<sub>4</sub> TYPE 1SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)  $\Delta$ 3.30A.

## SPALL

45 hr

## COLLECTED SPALL

NiO

Ni(M.M.)O<sub>4</sub> TYPE 1SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)  $\Delta$ 3.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

Ni(M.M.)O<sub>4</sub> TYPE 1

NiO

SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)  $\Delta$ 3.30A.SPINEL.  $\theta$ -8.10A.

## FACE CENTERED CUBIC MATRIX

100 hr

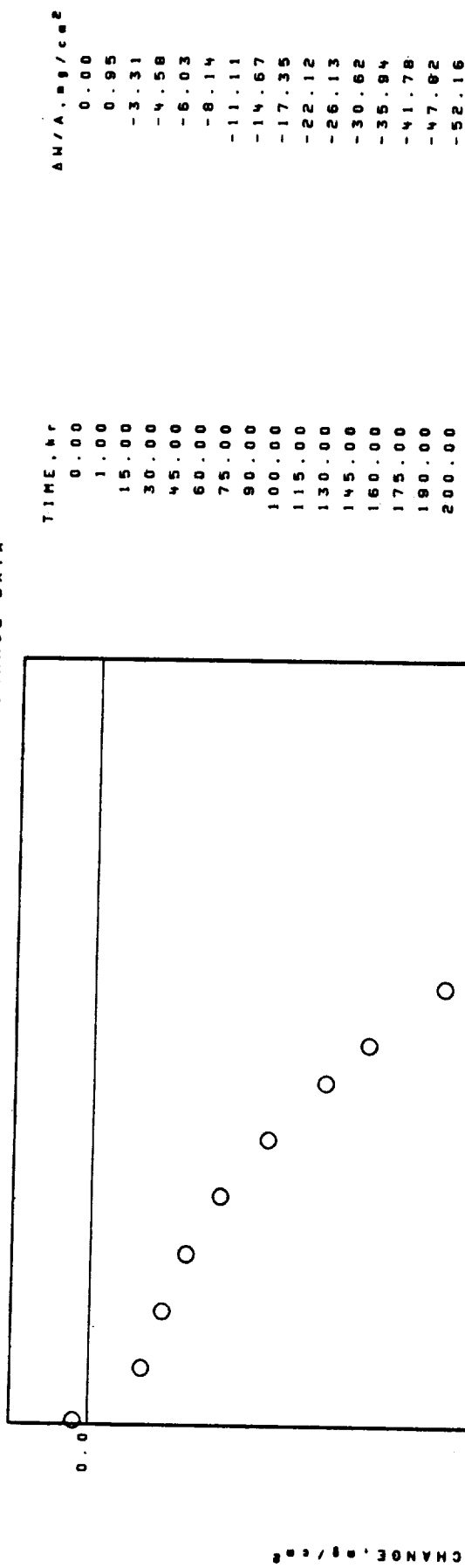
## COLLECTED SPALL

NiO

Ni(M.M.)O<sub>4</sub> TYPE 1SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)  $\Delta$ 3.30A.

NI BASE  
 MAR-M-200  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.297mm THICK STATIC AIR  
 02-04-008-310-3

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

THICK STATIC AIR

200.00hr TEST 2.297mm

1100°C 1.00hr CYCLES

MAR-M-200

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

NIO

SPINEL,  $\theta_0=8.18A$ .

SPINEL,  $\theta_0=8.25A$ .

NI(W.M.)O<sub>4</sub> TYPE 1

TRI(RUTILE).4(110)S3.30A.

(NI.Co.Fe)TiO<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

200 hr

COLLECTED SPALL

NIO

NI(W.M.)O<sub>4</sub> TYPE 1

SPINEL,  $\theta_0=8.25A$ .

TRI(RUTILE).4(110)S3.30A.

# COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

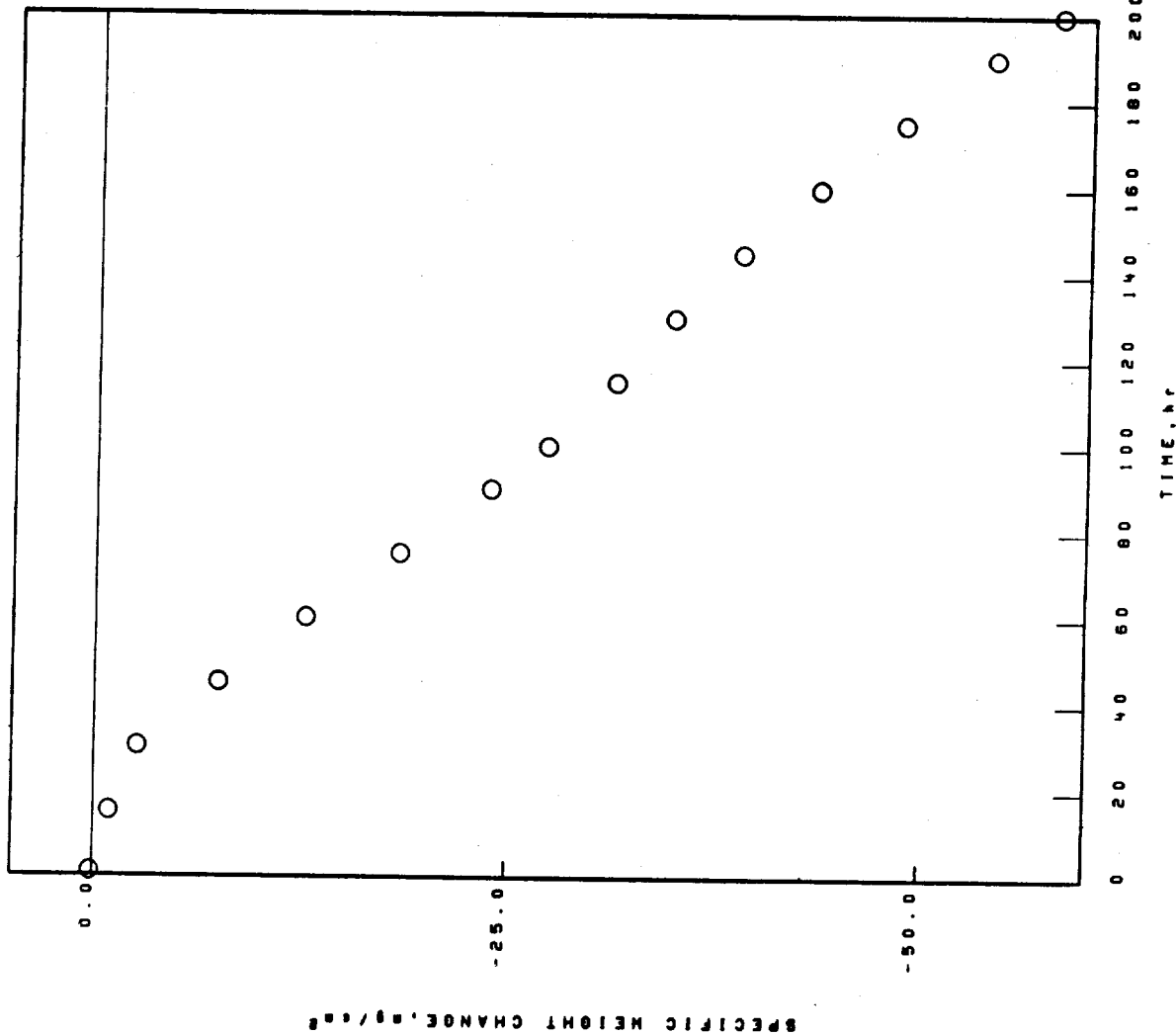
02-04-008-391-1

N1 BASE

MAR-M-200

1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.16
15.00	-0.96
30.00	-2.62
45.00	-7.51
60.00	-12.75
75.00	-18.37
90.00	-23.86
100.00	-27.27
115.00	-31.38
130.00	-34.87
145.00	-38.91
160.00	-43.53
175.00	-48.60
190.00	-54.06
200.00	-58.06



NI BASE  
 MAR-M-200  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.312" THICK STATIC AIR  
 02-04-008-391-1

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0$ -8.10A.  
 NiO  
 Ni(W.M.) $\theta_0$ , TYPE 1  
 SPINEL.  $\theta_0$ -8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)53.30A.  
 SPALL  
 100 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.) $\theta_0$ , TYPE 1  
 SPINEL.  $\theta_0$ -8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta_0$ -8.10A.  
 Ni(W.M.) $\theta_0$ , TYPE 1  
 TRI(RUTILE).  $\theta_0$ (110)53.30A.  
 SPINEL.  $\theta_0$ -8.25A.  
 200 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.) $\theta_0$ , TYPE 1  
 SPINEL.  $\theta_0$ -8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)53.30A.

FACE CENTERED CUBIC MATRIX

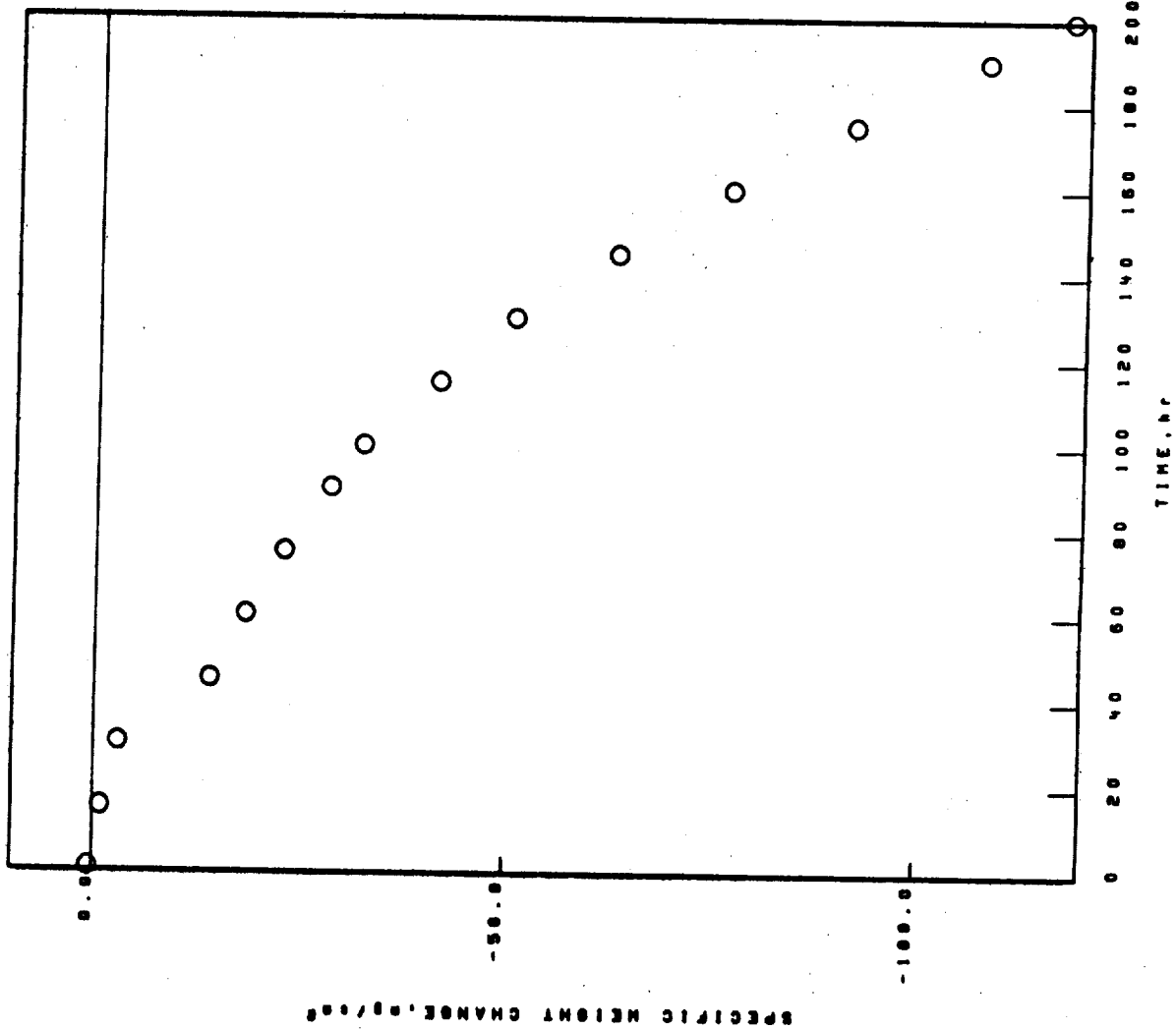
MI BASE  
MAR-M-200

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-000-391-2

1100°C 1.00hr CYCLES 200.00hr TEST 2.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-008-391-2  
 MAR-M-200                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.302mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

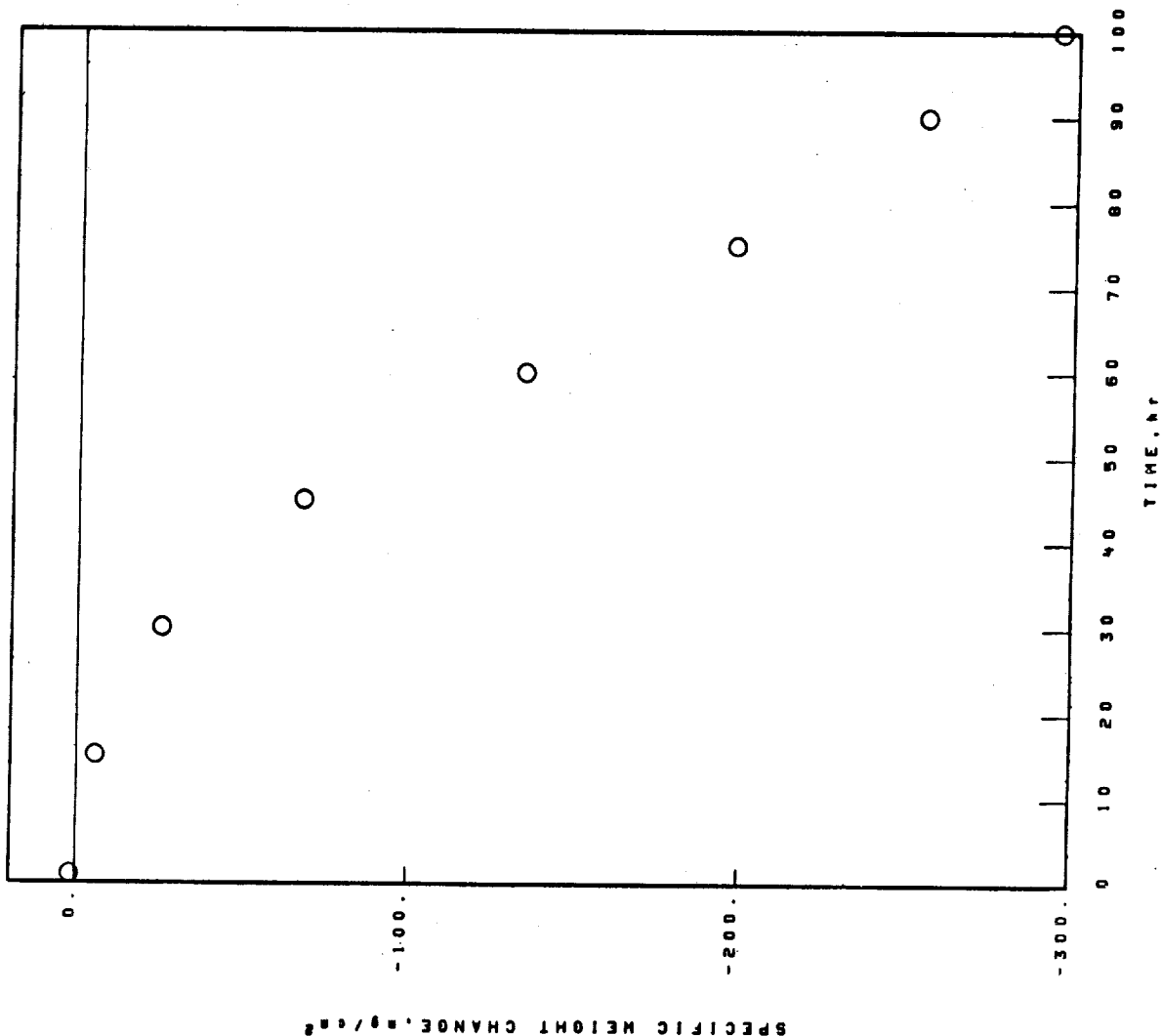
SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
SPINEL, $\theta_0=8.10A$ .	NI(W.M.)O, TYPE 1
NI(W.M.)O, TYPE 1	SPINEL, $\theta_0=8.25A$ .
SPINEL, $\theta_0=8.25A$ .	TRI(RUTILE), $\theta_0(110) \leq 3.30A$ .
TRI(RUTILE), $\theta_0(110) \leq 3.30A$ .	

FACE CENTERED CUBIC MATRIX

200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
NI(W.M.)O, TYPE 1	NI(W.M.)O, TYPE 1
SPINEL, $\theta_0=8.25A$ .	SPINEL, $\theta_0=8.25A$ .
TRI(RUTILE), $\theta_0(110) \leq 3.30A$ .	TRI(RUTILE), $\theta_0(110) \leq 3.30A$ .
SPINEL, $\theta_0=8.10A$ .	
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES. $\theta$ VALUES
	2.05A.

N1 BASE  
 MAR-M-200-M7  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.314mm THICK STATIC AIR  
 02-04-009-392-3

SPECIFIC WEIGHT CHANGE DATA



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

1150°C 1.00hr CYCLES 100.00hr TEST 2.314mm THICK STATIC AIR

MAR-M-200-H7

## X-RAY DIFFRACTION DATA

## SURFACE

45 hr

## STANDARD SURFACE

NiO

Ni(W.M.)<sub>10</sub>, TYPE 1

SPINEL. 80-8.10A.

SPINEL. 80-8.25A.

TRI(RUTILE). 4(110)53.30A.

HfO<sub>2</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

Ni(W.M.)<sub>10</sub>, TYPE 1

NiO

SPINEL. 80-8.25A.

## FACE CENTERED CUBIC MATRIX

## SPALL

45 hr

## COLLECTED SPALL

NiO

Ni(W.M.)<sub>10</sub>, TYPE 1

SPINEL. 80-8.25A.

TRI(RUTILE). 4(110)53.30A.

HfO<sub>2</sub>

100 hr

## COLLECTED SPALL

NiO

Ni(W.M.)<sub>10</sub>, TYPE 1

SPINEL. 80-8.25A.

TRI(RUTILE). 4(110)53.30A.

HfO<sub>2</sub>

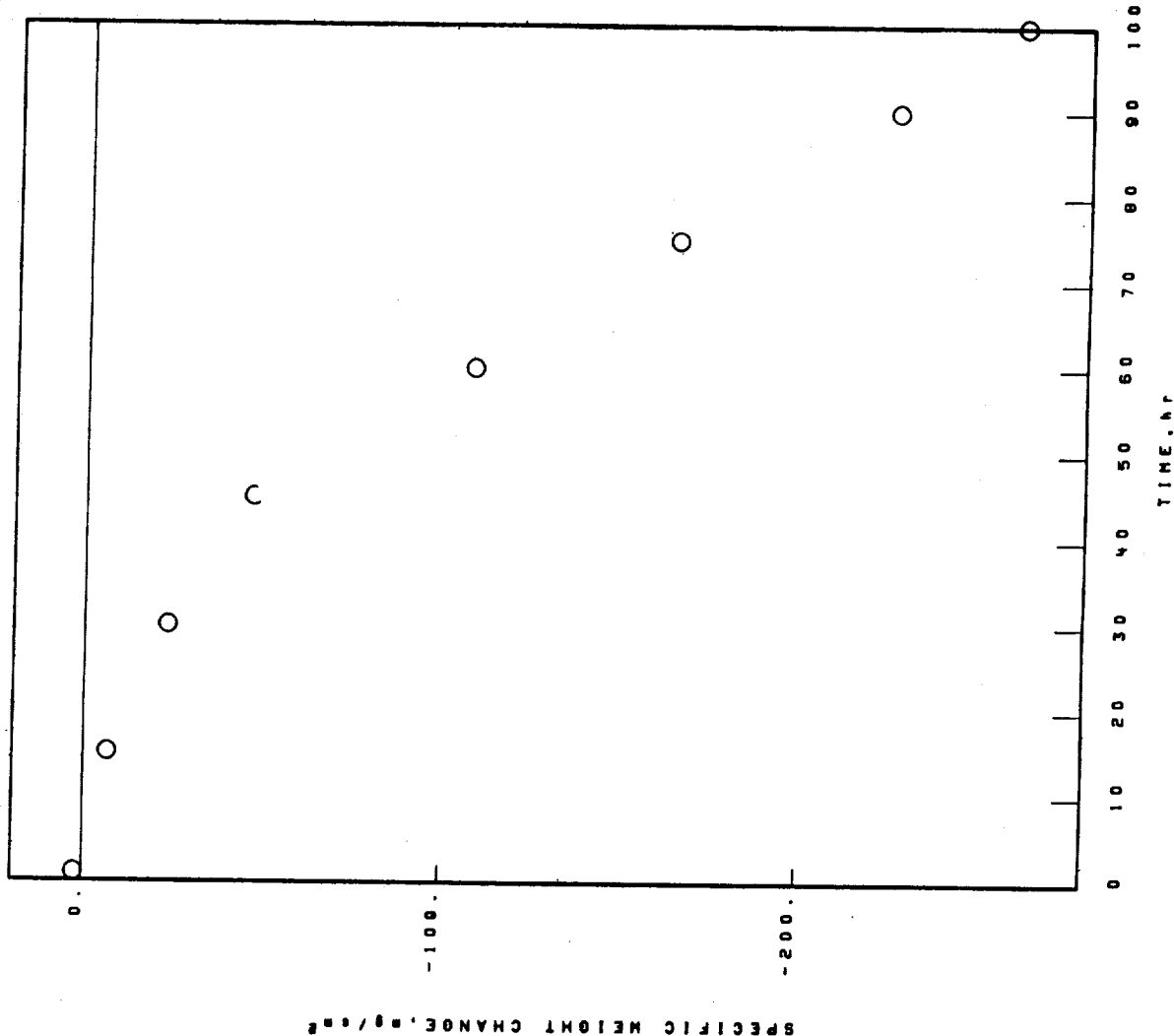
NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-009-382-6

MAR-M-200+Mf

1150°C 1.00hr CYCLES 100.00hr TEST 2.330mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
2.27  
-6.69  
-23.10  
-46.74  
-108.36  
-164.96  
-225.98  
-261.37

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-392-6  
 MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.330mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 45 hr  
 STANDARD SURFACE  
 NIO  
 NI(W.M.)O<sub>4</sub> TYPE I  
 SPINEL.  $\theta$ -8.10A.  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).4(110)13.30A.  
 HfO<sub>2</sub>

SPALL  
 45 hr  
 COLLECTED SPALL  
 NIO  
 NI(W.M.)O<sub>4</sub> TYPE I  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).4(110)13.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

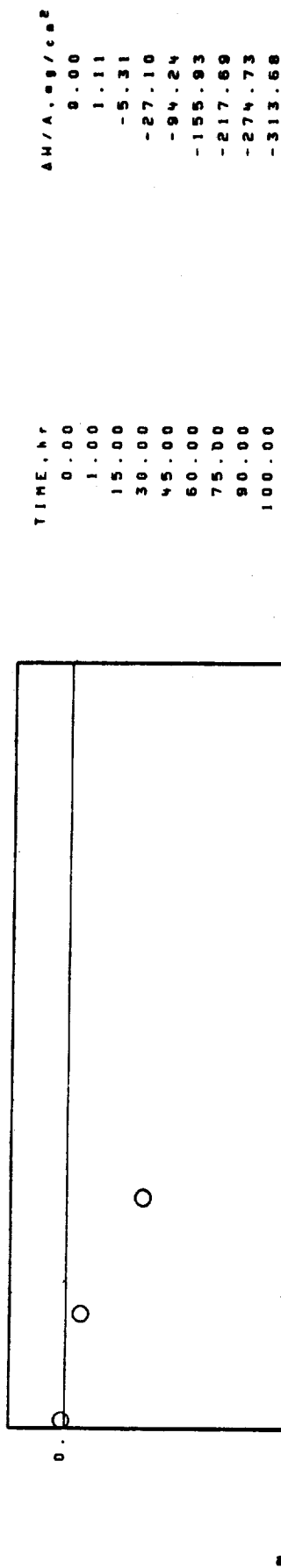
100 hr  
 STANDARD SURFACE  
 NI(W.M.)O<sub>4</sub> TYPE I  
 NIO  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).4(110)13.30A.  
 SPINEL.  $\theta$ -8.10A.  
 HfO<sub>2</sub>

100 hr  
 COLLECTED SPALL  
 NIO  
 NI(W.M.)O<sub>4</sub> TYPE I  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).4(110)13.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

NI BASE  
 DS-MAR-M-200-Hr  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.284mm THICK  
 02-04-010-392-4  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-392-4  
 DS-MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.284mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 45 hr  
 STANDARD SURFACE  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL. 80-8.10A.  
 SPINEL. 80-8.25A.  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>

SPALL  
 45 hr  
 COLLECTED SPALL  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL. 80-8.25A.  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

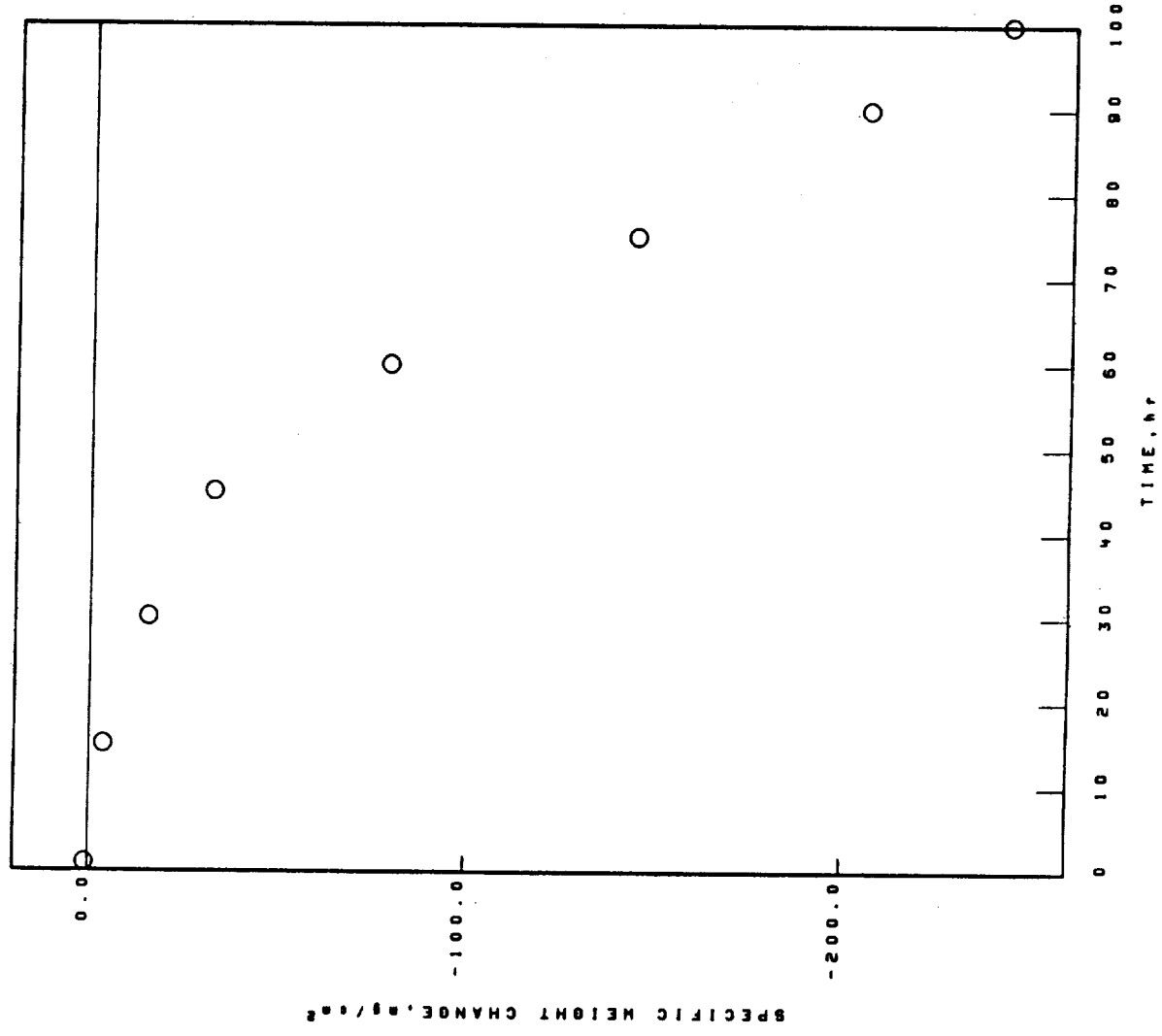
100 hr  
 STANDARD SURFACE  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 NIO  
 SPINEL. 80-8.25A.  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>

100 hr  
 COLLECTED SPALL  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL. 80-8.25A.  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

NI BASE  
 DS-MAR-M-200-M1  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR  
 02-04-010-392-5

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.88
15.00	-3.76
30.00	-15.32
45.00	-32.47
60.00	-79.04
75.00	-144.28
90.00	-205.61
100.00	-242.83

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-392-5  
 DS-MAR-W-200+M1 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 45 hr  
 STANDARD SURFACE  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta_0$ =8.10A.  
 SPINEL.  $\theta_0$ =8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)13.30A.  
 HfO<sub>2</sub>

SPALL  
 45 hr  
 COLLECTED SPALL  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta_0$ =8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)13.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 NIO  
 SPINEL.  $\theta_0$ =8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)13.30A.  
 HfO<sub>2</sub>

100 hr  
 COLLECTED SPALL  
 NIO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta_0$ =8.25A.  
 TRI(RUTILE).  $\theta_0$ (110)13.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

HAR-M-200+HT

1100°C

0.03%/ CYCLES

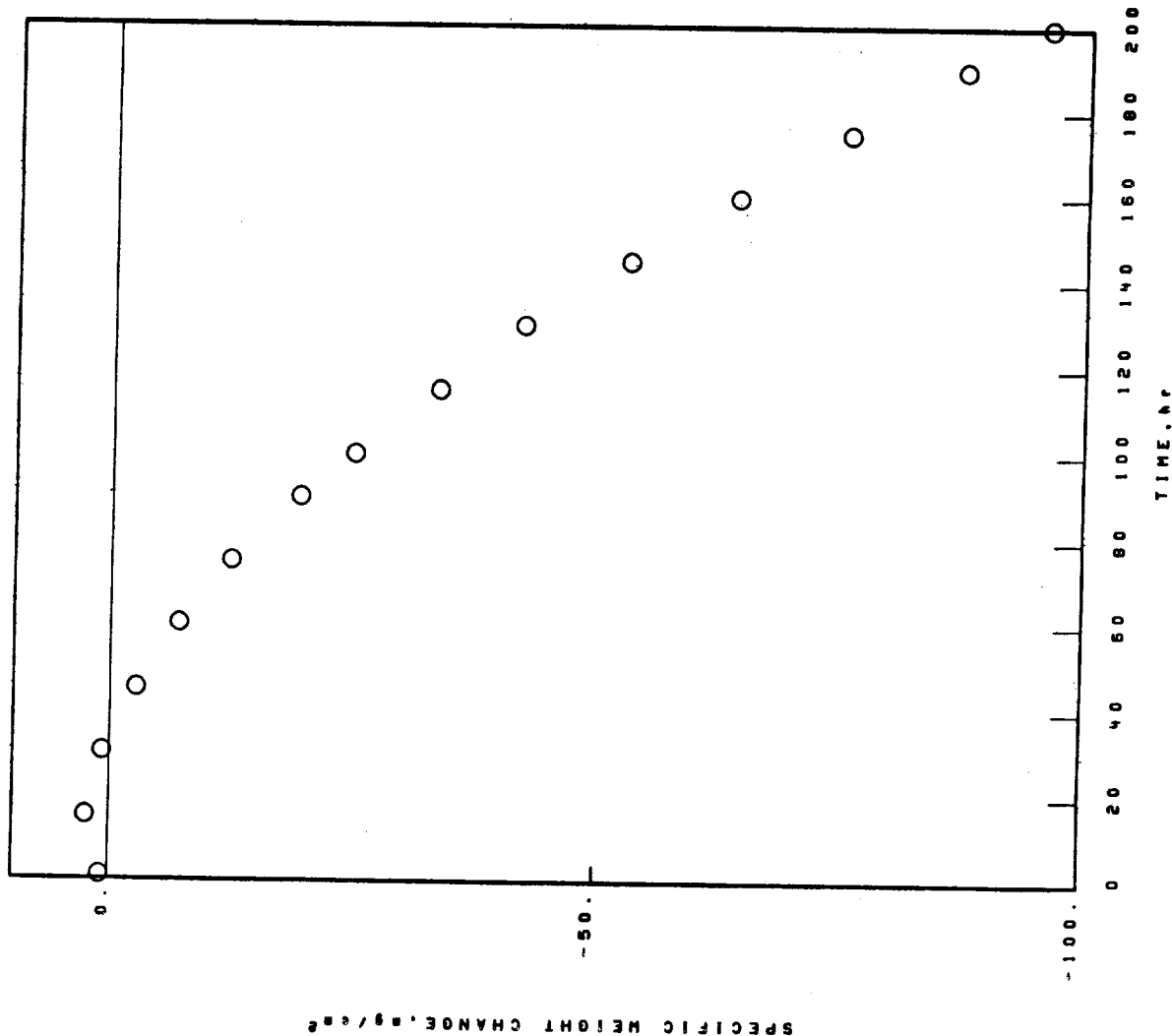
200.00hr TEST

2.300mm THICK

STATIC AIR

02-04-009-310-4

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cm²  
0.00  
0.93  
2.46  
0.78  
-2.64  
-7.00  
-12.32  
-19.32  
-24.86  
-33.55  
-42.17  
-53.01  
-64.08  
-75.43  
-87.23  
-95.85

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST 2.300mm

1100°C 0.03hr CYCLES

MAR-M-200-H1

## X-RAY DIFFRACTION DATA

## SURFACE

200 hr

## STANDARD SURFACE

NiO

SPINEL,  $\alpha$ -8-25A.SPINEL,  $\alpha$ -8-10A.

Ni(W.M.)O, TYPE I

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

## SPALL

200 hr

## COLLECTED SPALL

NiO

Ni(W.M.)O, TYPE I

SPINEL,  $\alpha$ -8-25A.

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

## FACE CENTERED CUBIC MATRIX

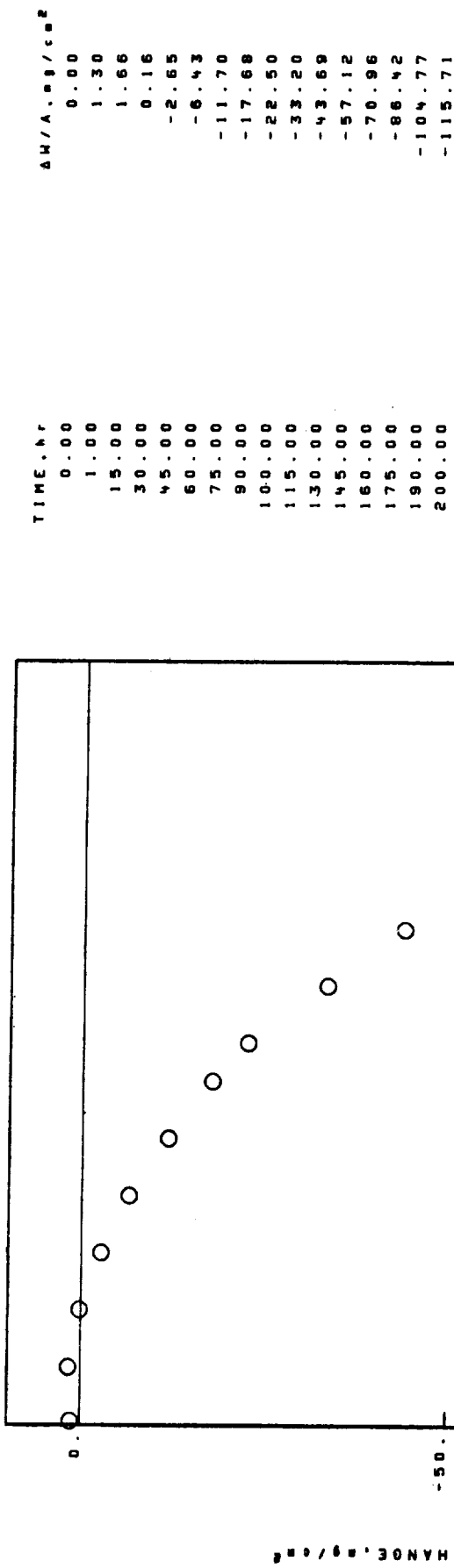
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

MAR-M-200+Mf

1100°C 1.00hr CYCLES 200.00hr TEST 2.322mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

**STATIC AIR**

2.322 ■ THICK

**TEST**

200.00 hr

## STUDY CYCLES

1100°C

MAR-M-200-HY

## X-RAY DIFFRACTION DATA

## SURFACE

10042

## STANDARD SURFACE

0-0-0

SPINEL. 80-8-30A.

**SPALL**

1004

COLLECTED SPALL.

0-2

MINIMUM TYPE I

SPINEL. #0 = 0.25A.

TRI(RUTILE), 4(110) 53.30A.

301H

2004

## STANDARD SURFACE

**Q 1 N**

**Ni(H<sub>2</sub>MoO<sub>4</sub>)<sub>2</sub> TYPE I**

SPINEL. 10-8.25A.

SPINEL, 20-8-10A.

TRI(RUTILE).  $d(110) \leq 3.30 \text{ \AA}$ .

2010

20044

COLLECTED SPALL

**W I O**

NI(W.M.)O, TYPE I

SPINEL. # 8.25A.

TRI(RUTILE),  $\theta(110) \leq 3.30^\circ$ .

201H

2102

UNKNOWN LINES, & VALUES

2.05X.

FACE CENTERED CUBIC MATRIX

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-200+M1

1100°C

1.00hr CYCLES

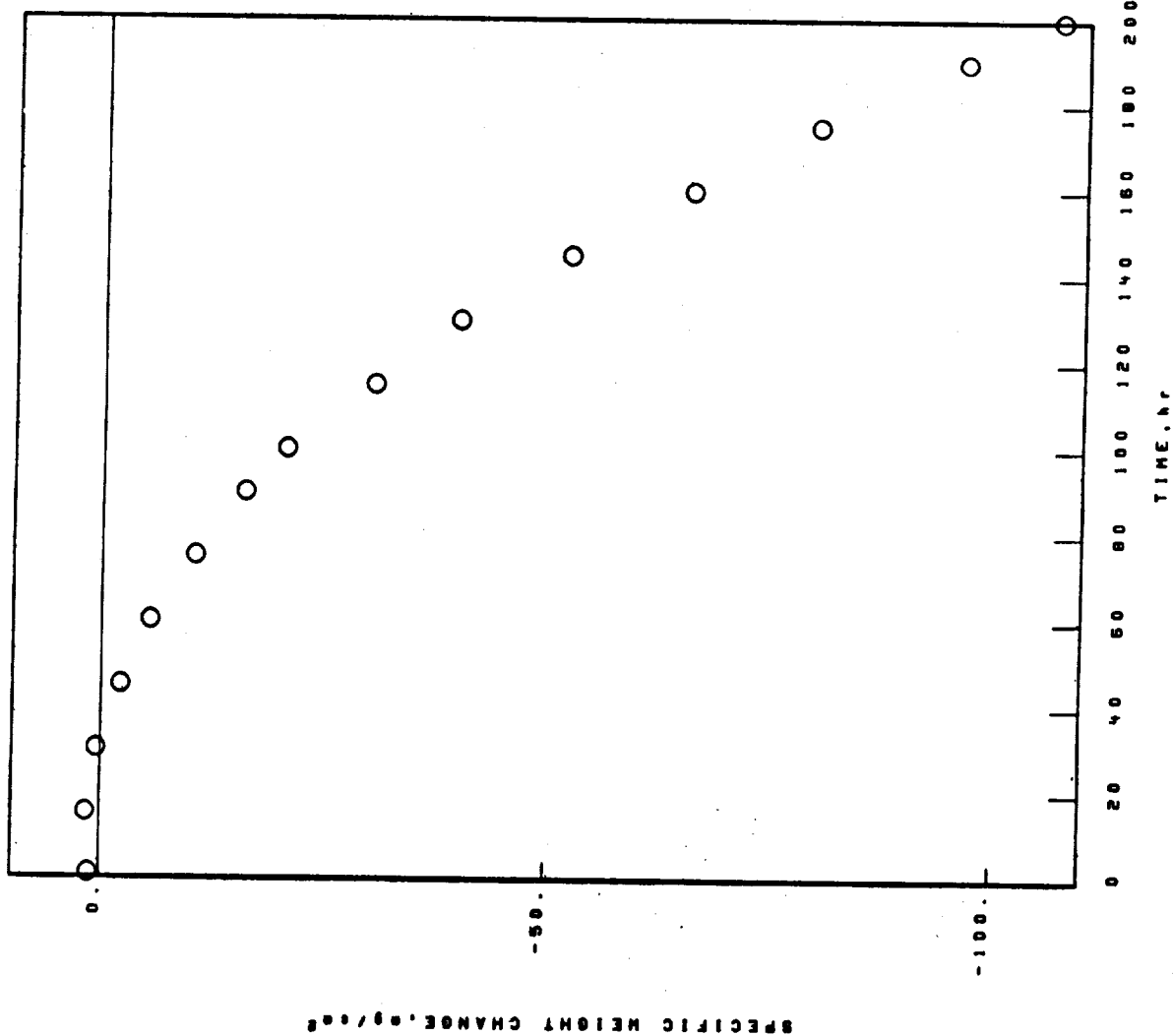
200.00hr TEST

2.268mm THICK

STATIC AIR

02-04-009-391-6

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-391-6  
 MAR-M-200+H7 1100°C 1.00hr CYCLES 200.00hr TEST 2.268mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr  
 STANDARD SURFACE  
 NIO  
 SPINEL.  $\theta_0$  = 8.30A.  
 HfO<sub>2</sub>

SPALL

100 hr  
 COLLECTED SPALL  
 NIO  
 Ni(W.M.)O<sub>x</sub> TYPE 1  
 SPINEL.  $\theta_0$  = 8.25A.  
 TRI(RUTILE).  $\theta_0$  (110)  $\theta_0$  3.30A.  
 HfO<sub>2</sub>

200 hr

STANDARD SURFACE

NIO  
 Ni(W.M.)O<sub>x</sub> TYPE 1  
 SPINEL.  $\theta_0$  = 8.10A.  
 SPINEL.  $\theta_0$  = 8.25A.  
 TRI(RUTILE).  $\theta_0$  (110)  $\theta_0$  3.30A.  
 HfO<sub>2</sub>

200 hr

COLLECTED SPALL

NIO  
 Ni(W.M.)O<sub>x</sub> TYPE 1  
 SPINEL.  $\theta_0$  = 8.25A.  
 TRI(RUTILE).  $\theta_0$  (110)  $\theta_0$  3.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

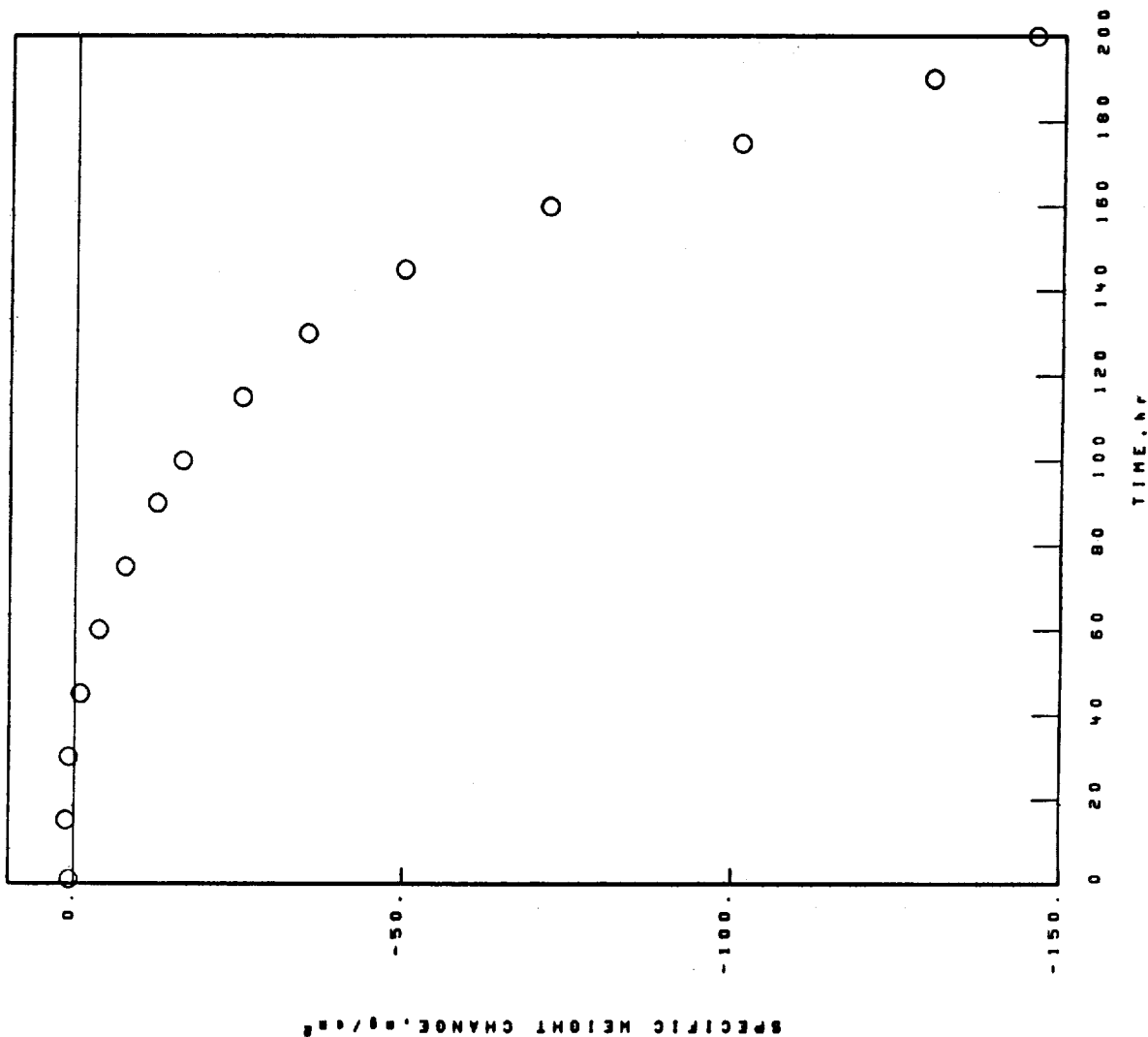
# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-010-391-4

DS-MAR-M-200-H7

1100°C 1.00hr CYCLES 200.00hr TEST 2.318mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-391-4  
 DS-MAR-M-200-H7 1100°C 1.00hr CYCLES 200.00hr TEST 2.318mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -8.30A.  
 NiO  
 SPINEL.  $\theta$ -8.10A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 HfO<sub>2</sub>  
 (Ni.Co.F.)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 NiO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta$ -8.10A.  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL  
 100 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 HfO<sub>2</sub>

200 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 HfO<sub>2</sub>

UNKNOWN LINES. 4 VALUES  
 2.05A.

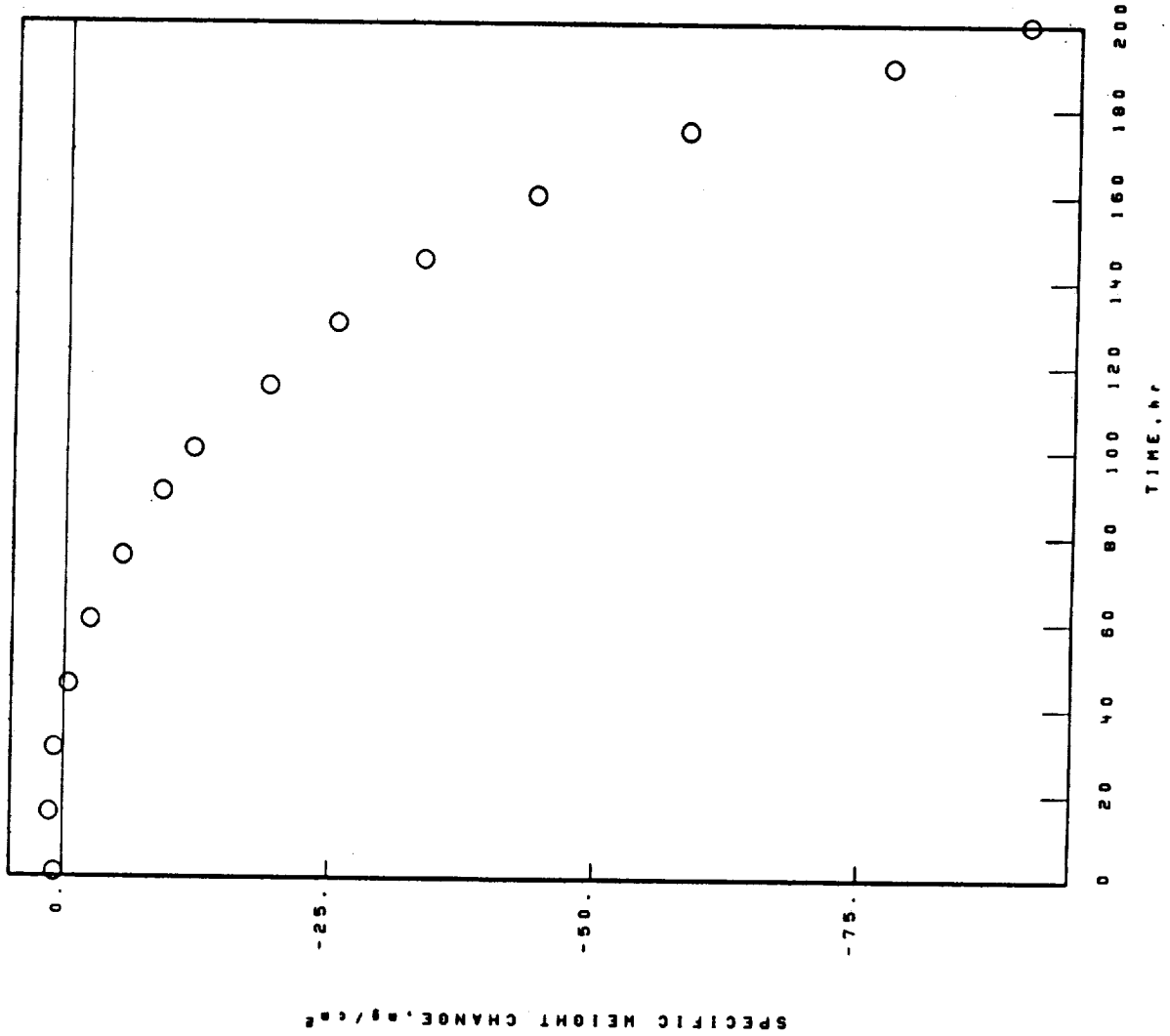
# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-010-391-5

DS-MAR-M-200-H1

1100°C 1.00hr CYCLES 200.00hr TEST 2.318mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.318mm

TEST 200.00hr

1.00hr CYCLES

1100°C

DS-MAR-M-200+M1

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $\theta$ -8.30A.

NiO

SPINEL.  $\theta$ -8.10A.

TRI(RUTILE).  $\theta$ (110)13.30A.

HfO<sub>2</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta$ -8.25A.

Ni(M.M.)O, TYPE I

SPINEL.  $\theta$ -8.10A.

TRI(RUTILE).  $\theta$ (110)13.30A.

HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NiO

Ni(M.M.)O, TYPE I

SPINEL.  $\theta$ -8.25A.

TRI(RUTILE).  $\theta$ (110)13.30A.

HfO<sub>2</sub>

200 hr

COLLECTED SPALL

NiO

Ni(M.M.)O, TYPE I

SPINEL.  $\theta$ -8.25A.

TRI(RUTILE).  $\theta$ (110)13.30A.

HfO<sub>2</sub>

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

DS-MAR-M-200+Hr

1100°C

1.00hr CYCLES

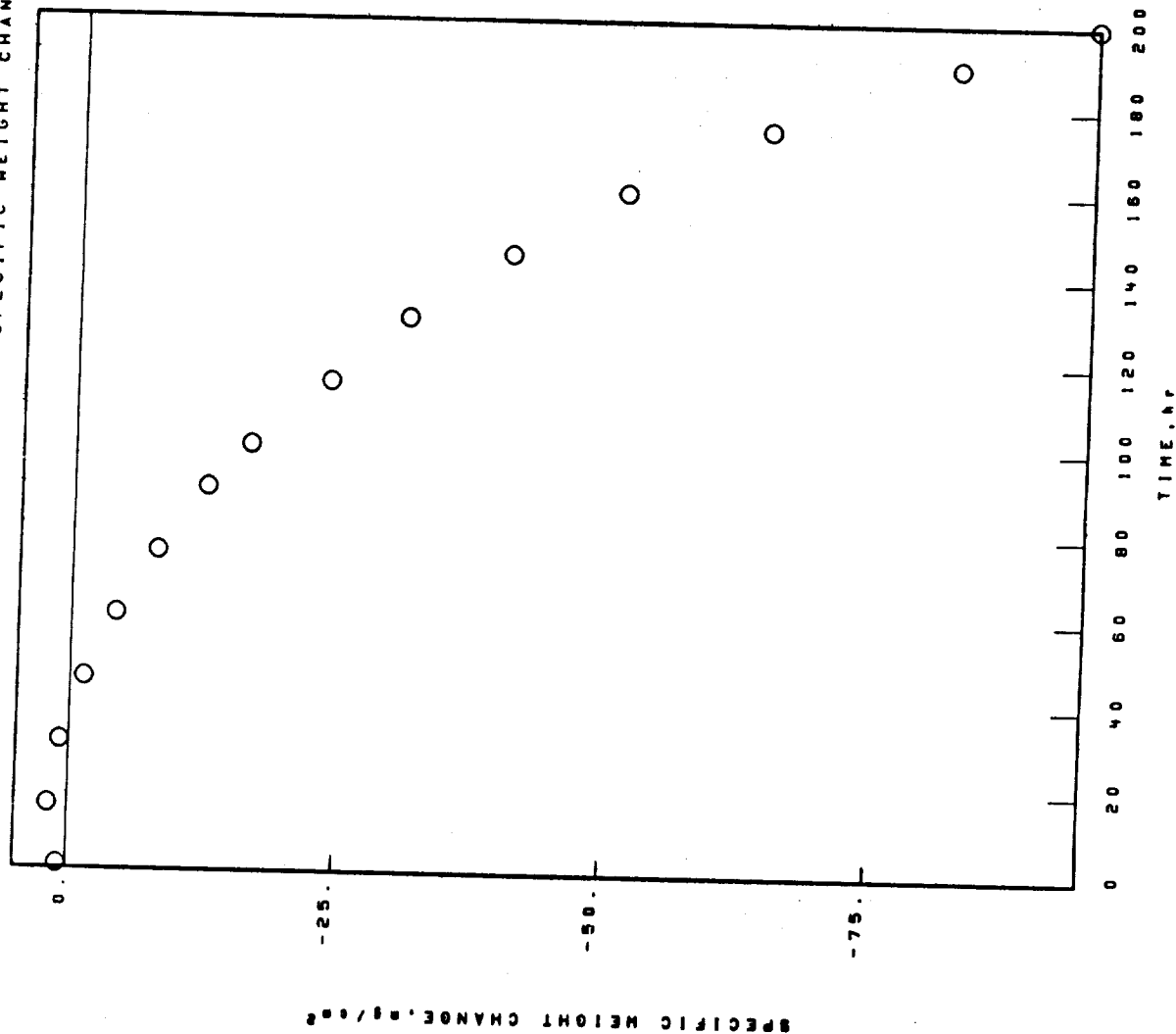
200.00hr TEST

2.324mm THICK

STATIC AIR

02-04-010-310-5

SPECIFIC WEIGHT CHANGE DATA



° N1 BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-310-5  
DS-MAR-M-200+M1 1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
N10	N10
NI(W.M.)O, TYPE 1	NI(W.M.)O, TYPE 1
SPINEL. 90-8.10A.	SPINEL. 90-8.25A.
SPINEL. 90-8.25A.	TRI(RUTILE).4(110)53.30A.
TRI(RUTILE).4(110)53.30A.	HfO <sub>2</sub>
HfO <sub>2</sub>	

FACE CENTERED CUBIC MATRIX

NI BASE

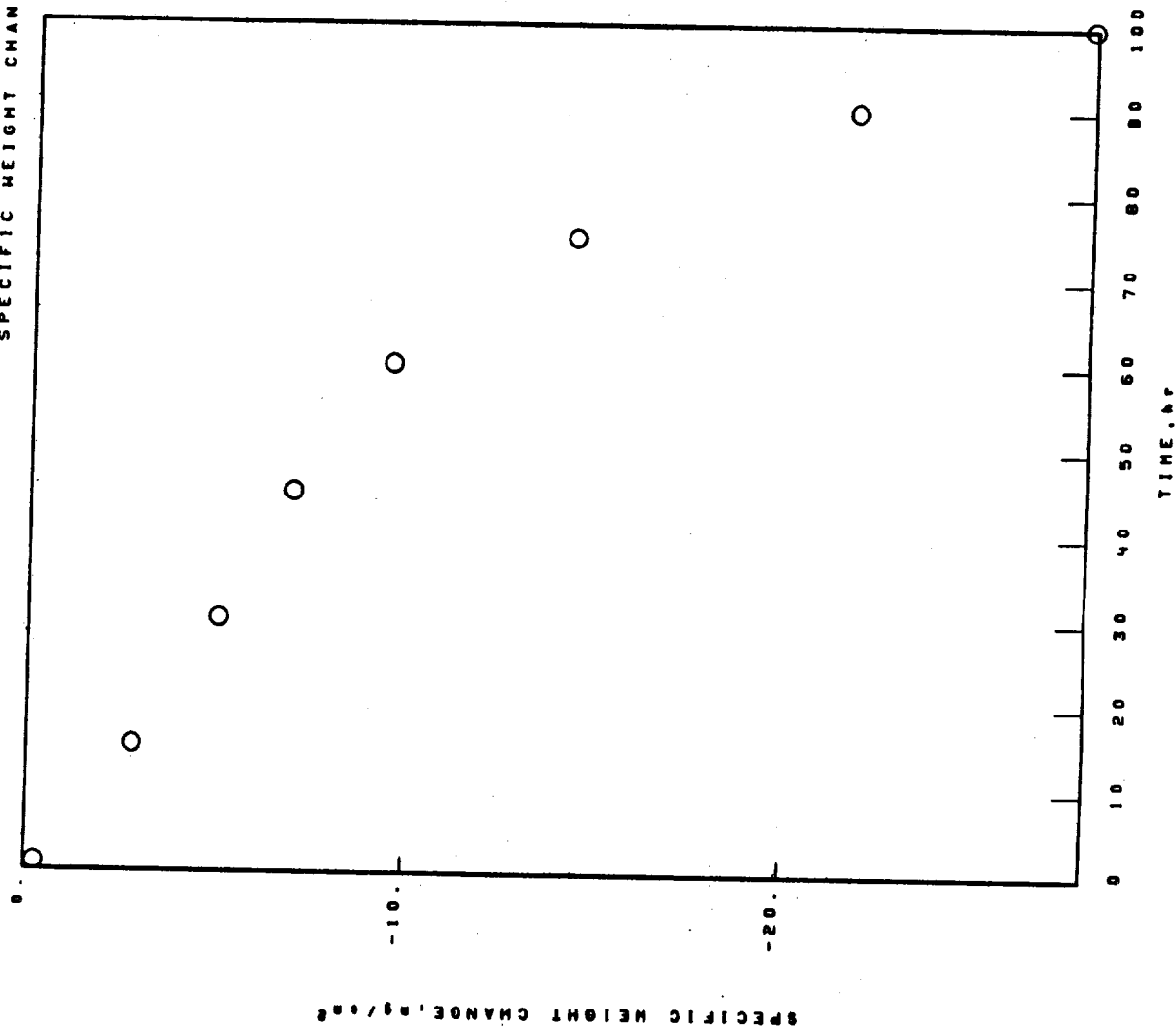
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-211

02-04-011-321-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
-0.26  
-2.78  
-5.04  
-6.95  
-9.54  
-14.33  
-21.73  
-27.93



NI BASE  
 MAR-M-211  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR  
 02-04-011-321-W

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, 80-8.10A.	NiO
TRI(RUTILE), 4(110)3.30A.	Ni(W.M.)O, TYPE 1
Al <sub>2</sub> O <sub>3</sub>	SPINEL, 80-8.25A.
	TRI(RUTILE), 4(110)3.30A.

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES, d VALUES  
 2.76A.

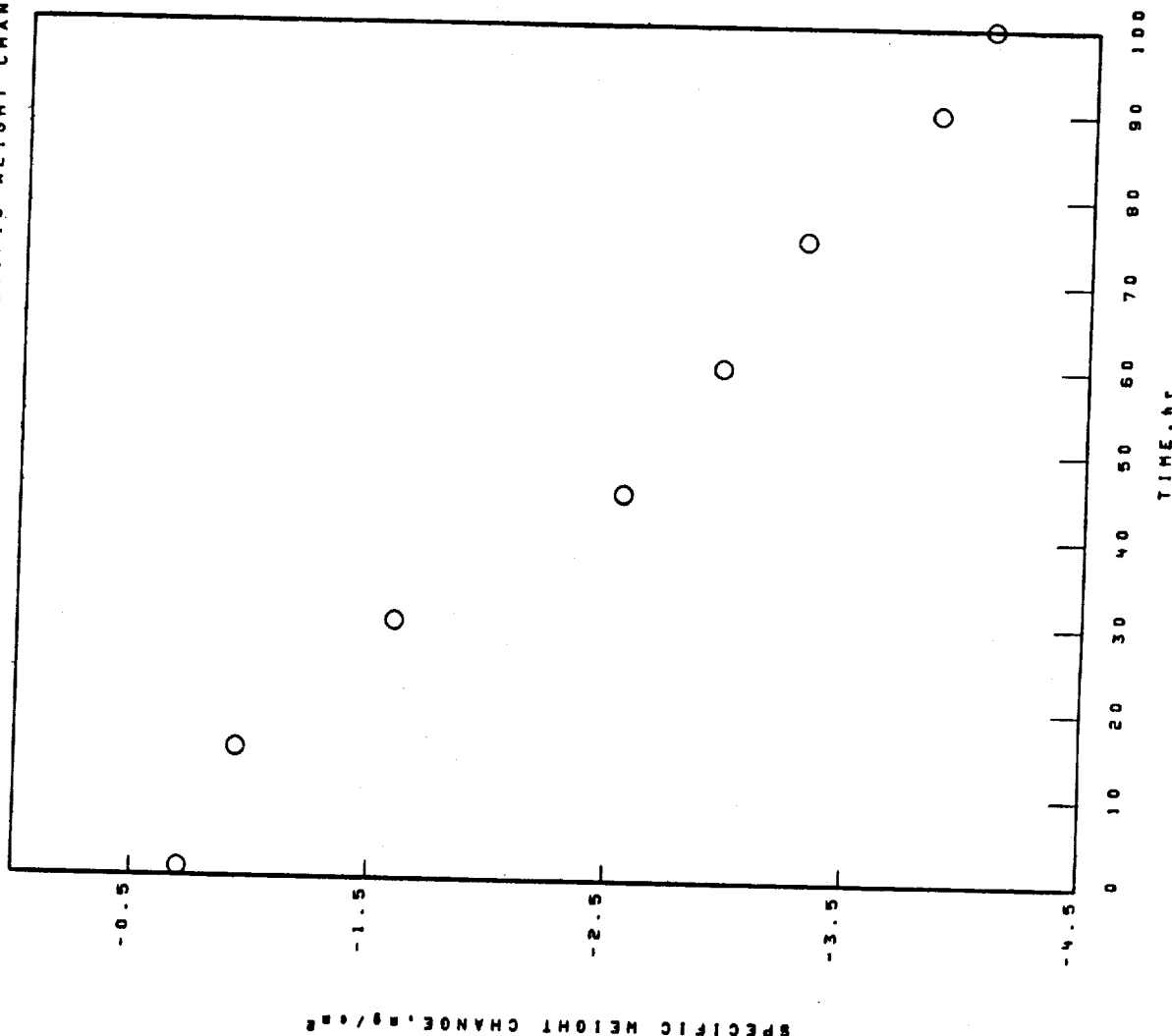
# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-211

02-04-011-472-6

1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
-0.70  
-0.94  
-1.58  
-2.55  
-2.85  
-3.30  
-3.84  
-4.06

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-472-6  
 MAR-M-211 1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

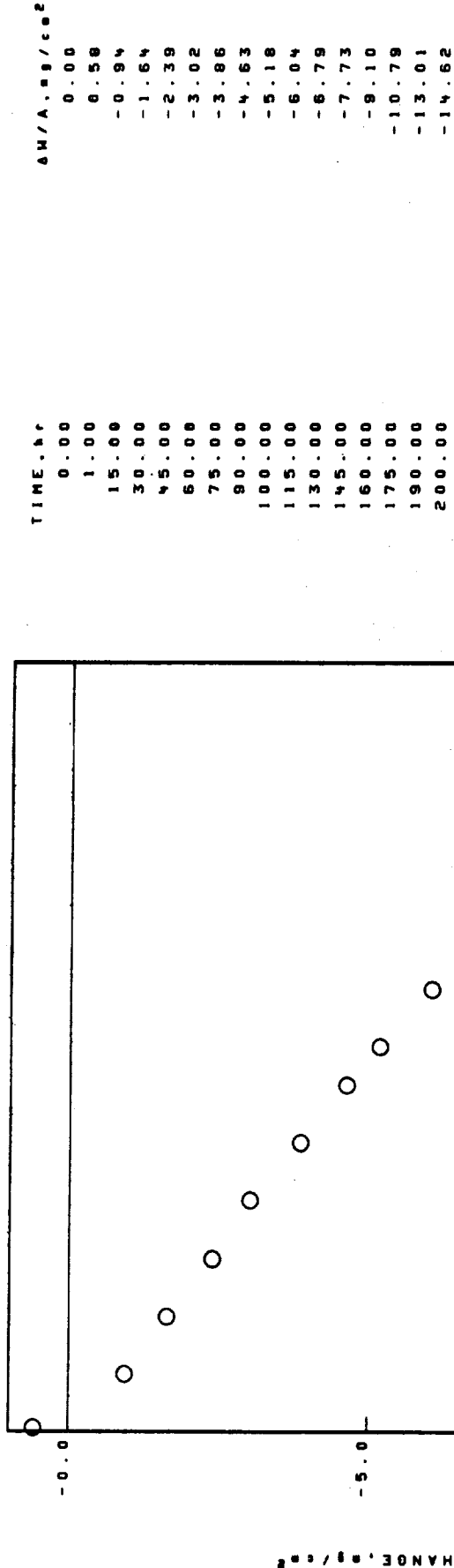
SURFACE	SPALL
1 hr	1 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $\theta_0=8.10A$ .	SPINEL, $\theta_0=8.25A$ .
TRI(RUTILE), $4(110) \leq 3.30A$ .	TRI(RUTILE), $4(110) \leq 3.30A$ .
Al <sub>2</sub> O <sub>3</sub>	NiO
	Cr <sub>2</sub> O <sub>3</sub>

FACE CENTERED CUBIC MATRIX	100 hr
	COLLECTED SPALL
	NiO
	SPINEL, $\theta_0=8.25A$ .
	TRI(RUTILE), $4(110) \leq 3.30A$ .
	(Ni,Cr,F) <sub>2</sub> TiO <sub>3</sub>
	SPINEL, $\theta_0=8.10A$ .
	UNKNOWN LINES, 4 VALUES
	3.56A.

100 hr	
STANDARD SURFACE	
SPINEL, $\theta_0=8.10A$ .	
NiO	
(Ni,Cr,F) <sub>2</sub> TiO <sub>3</sub>	
TRI(RUTILE), $4(110) \leq 3.30A$ .	
TRI(RUTILE), $4(110) \leq 3.30A$ .	
SPINEL, $\theta_0=8.20A$ .	
FACE CENTERED CUBIC MATRIX	

NI BASE  
 MAR-M-211  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.245mm THICK STATIC AIR  
 02-04-011-473-6

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1100°C 1.00hr CYCLES 200.00hr TEST 2.245mm THICK STATIC AIR

MAR-M-211

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL,  $\theta_0$ -8.25A.

TRI(RUTILE), 4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL,  $\theta_0$ -8.10A.

NI<sub>2</sub>O

TRI(RUTILE), 4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL,  $\theta_0$ -8.10A.

Al<sub>2</sub>O<sub>3</sub>

NI<sub>2</sub>O

TRI(RUTILE), 4(110)53.30A.

(NI,Co,Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NI<sub>2</sub>O

SPINEL,  $\theta_0$ -8.25A.

TRI(RUTILE), 4(110)53.30A.

NI(W.M.)O, TYPE 1

SPINEL,  $\theta_0$ -8.10A.

Cr<sub>2</sub>O<sub>3</sub>

200 hr

COLLECTED SPALL

NI<sub>2</sub>O

SPINEL,  $\theta_0$ -8.25A.

NI(W.M.)O, TYPE 1

NI BASE  
MAR-M-211

02-04-011-479-1

1100°C

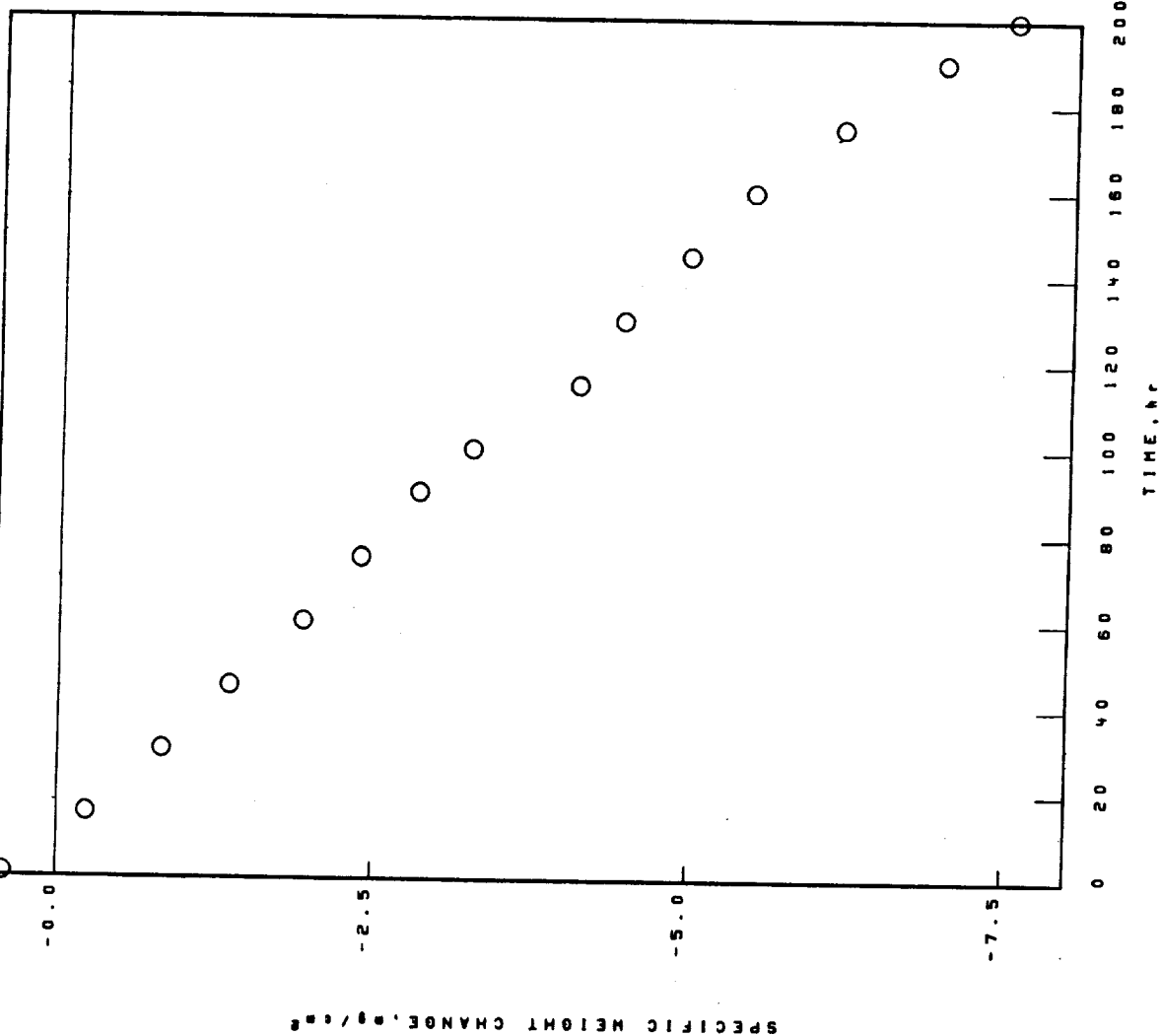
1.00hr CYCLES

200.00hr TEST

2.258mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cc
0.00	0.00
1.00	0.42
15.00	-0.23
30.00	-0.83
45.00	-1.36
60.00	-1.93
75.00	-2.38
90.00	-2.84
100.00	-3.26
115.00	-4.10
130.00	-4.44
145.00	-4.96
160.00	-5.45
175.00	-6.16
180.00	-6.85
200.00	-7.51

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-479-1  
 HAR-M-211 1100°C 1.00hr CYCLES 200.00hr TEST 2.258mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

SPINEL,  $\theta_0=8.25A$ .

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE),  $4(110) \{3.30A$ .

Al<sub>2</sub>O<sub>3</sub>

(Ni,Cr,F)TiO<sub>3</sub>

SPINEL,  $\theta_0=8.15A$ .

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL,  $\theta_0=8.10A$ .

NiO

TRI(RUTILE),  $4(110) \{3.30A$ .

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL,  $\theta_0=8.10A$ .

Al<sub>2</sub>O<sub>3</sub>

NiO

TRI(RUTILE),  $4(110) \{3.30A$ .

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO

SPINEL,  $\theta_0=8.30A$ .

ZrO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE),  $4(110) \{3.30A$ .

200 hr

COLLECTED SPALL

NiO

SPINEL,  $\theta_0=8.25A$ .

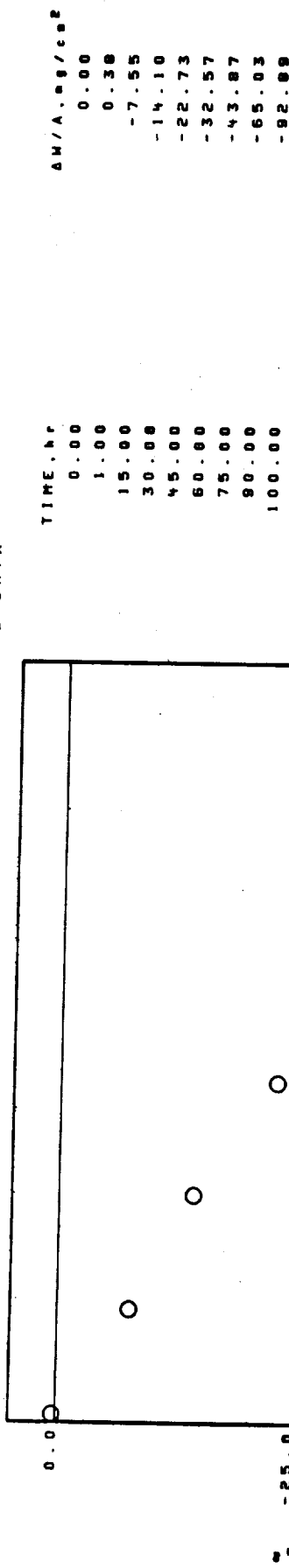
TRI(RUTILE),  $4(110) \{3.30A$ .

# NI BASE MAR-M-246

02-04-012-322-3

1150°C 1.00hr CYCLES 100.00hr TEST 2.238mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA





COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.238mm

TEST 100.00hr

CYCLES 1.00hr

1150°C

NI BASE

MAR-M-246

# X-RAY DIFFRACTION DATA

SPALL  
100 hr  
COLLECTED SPALL  
NIO  
SPINEL.  $\theta$ -8.25A.  
SPINEL.  $\theta$ -8.05A.  
TRI(RUTILE).4(110)13.30A.

SURFACE  
100 hr  
STANDARD SURFACE  
NIO  
SPINEL.  $\theta$ -8.25A.  
TRI(RUTILE).4(110)13.30A.  
SPINEL.  $\theta$ -8.10A.  
Al<sub>2</sub>O<sub>3</sub>  
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

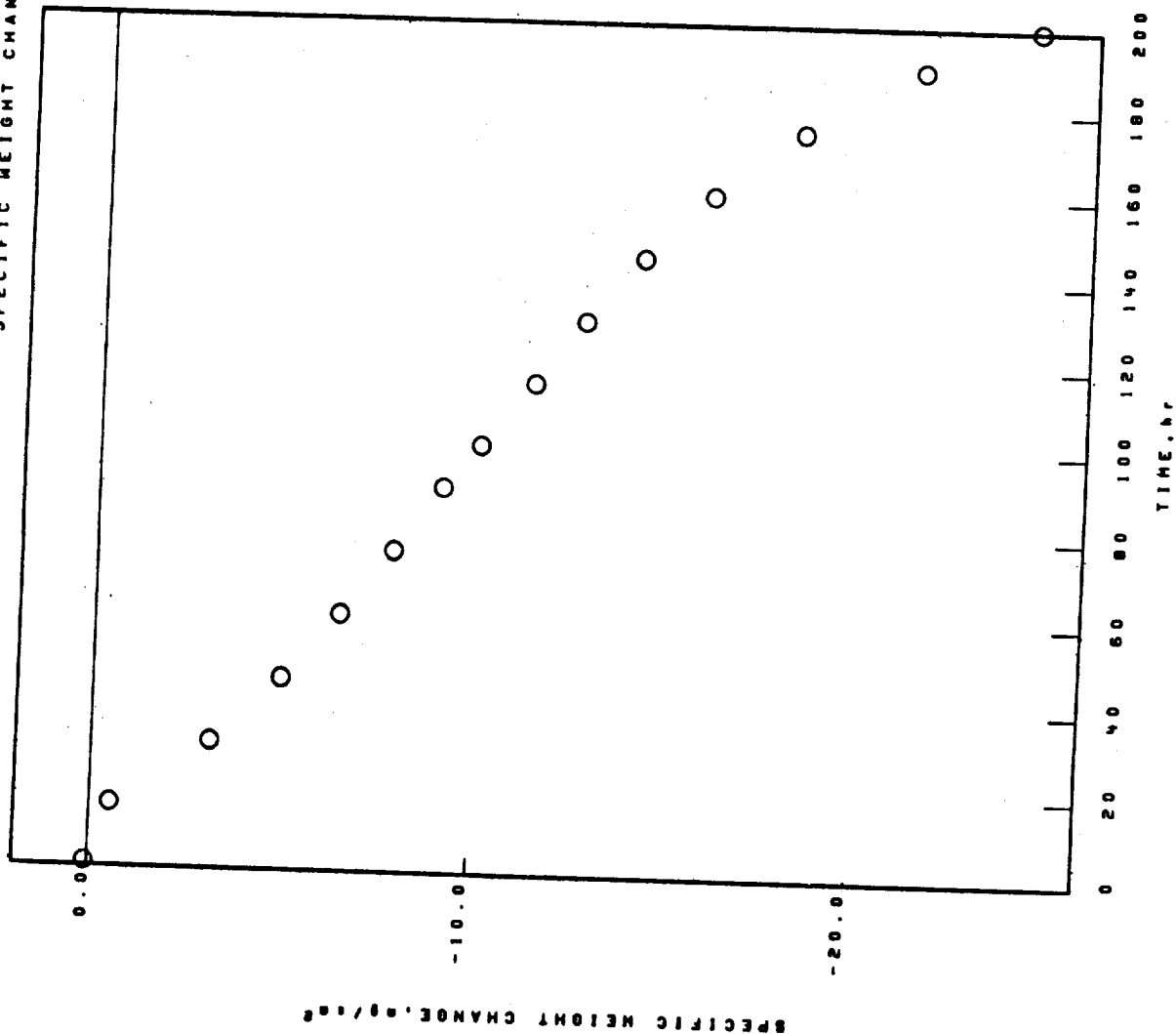
NI BASE  
MAR-M-246

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

1100°C 1.00hr CYCLES 200.00hr TEST 2.249mm THICK STATIC AIR

02-04-012-325-3

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cm²  
0.00  
0.00  
-0.53  
-3.12  
-4.85  
-6.44  
-7.80  
-9.05  
-10.02  
-11.39  
-12.67  
-14.18  
-15.87  
-18.29  
-21.42  
-24.44

N1 BASE  
 MAR-M-246  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.249mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $\theta_0=8.10A$ .	NIO
NIO	SPINEL, $\theta_0=8.30A$ .
SPINEL, $\theta_0=8.25A$ .	TRI(RUTILE), $\theta(110)13.30A$ .
TRI(RUTILE), $\theta(110)13.30A$ .	
Cr <sub>2</sub> O <sub>3</sub>	

FACE CENTERED CUBIC MATRIX

NI BASE

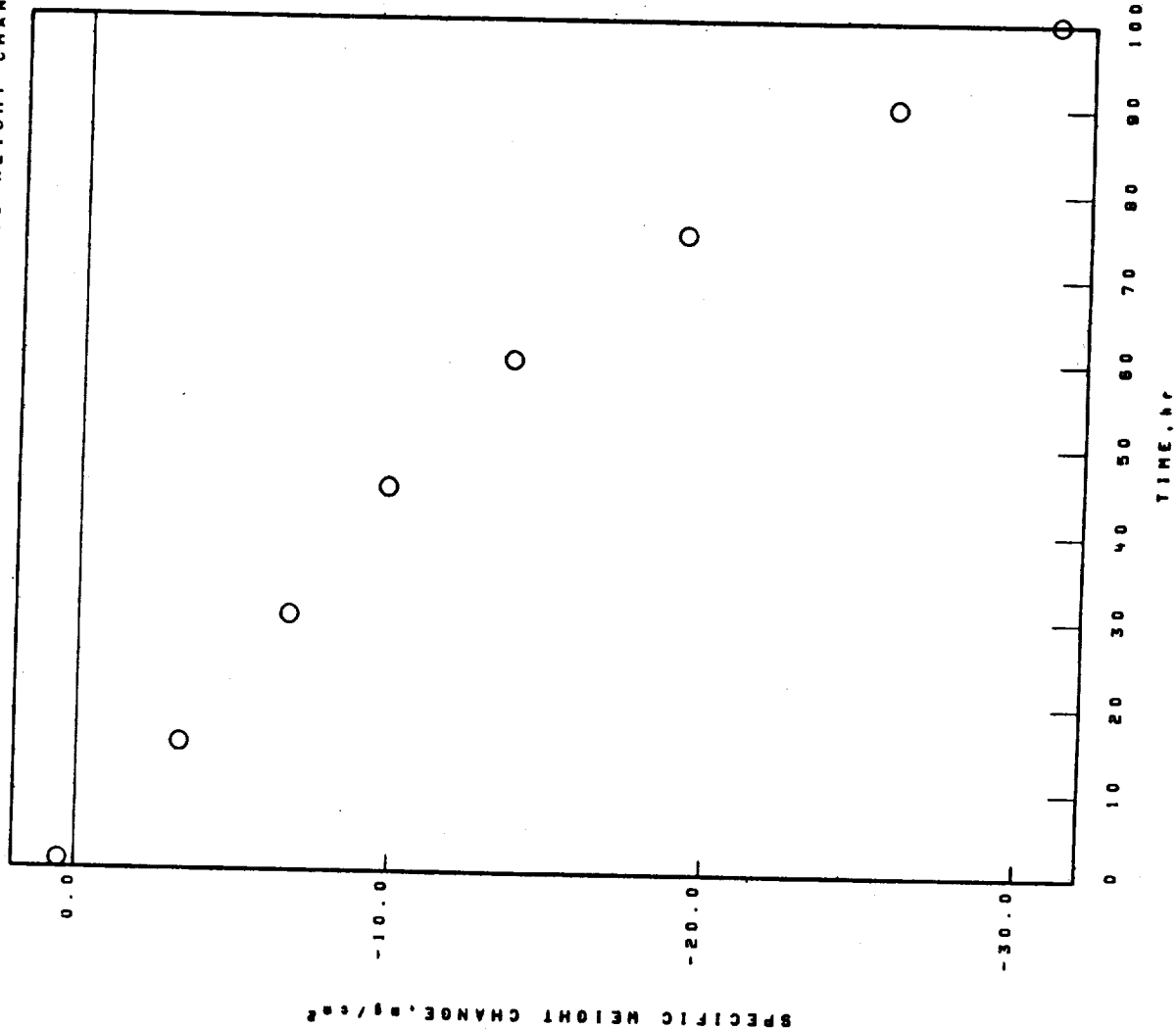
EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM MAR-M-247-9.76C.

02-09-108-482-3

1150°C 1.00hr CYCLES 100.00hr TEST 2.300mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.52  
-3.30  
-6.73  
-8.80  
-13.69  
-19.13  
-25.73  
-30.86

NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-108-482-3  
 COSAM MAR-M-247-9.76C 1150°C 1.00hr CYCLES 100.00hr TEST 2.300mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 SPINEL. 90-8.20A.  
 NI(M.M.)10% TYPE I  
 TRI(RUTILE).4(110)3.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>

SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 90-8.10A.  
 NiO  
 SPINEL. 90-8.25A.  
 TRI(RUTILE).4(110)3.30A.  
 HfO<sub>2</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 Al<sub>2</sub>O<sub>3</sub>

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 90-8.10A.  
 SPINEL. 90-8.25A.  
 TRI(RUTILE).4(110)3.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM MAR-M-247-9.76C.

1150°C

1.00hr CYCLES

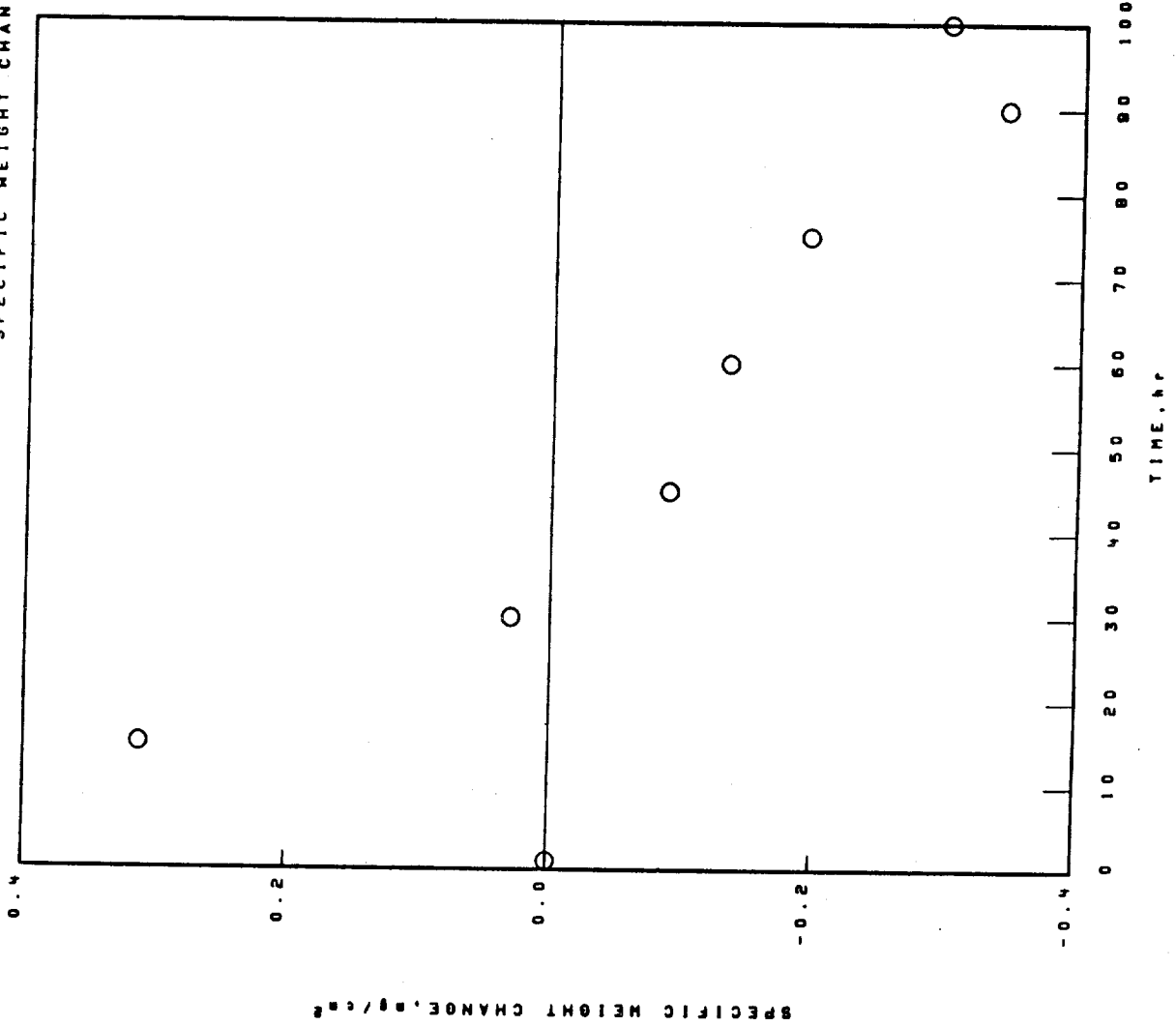
100.00hr TEST

2.294mm THICK

STATIC AIR

02-09-108-656-1

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.00  
0.31  
0.03  
-0.09  
-0.13  
-0.19  
-0.24  
-0.30

NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-108-656-1  
 COSAM MAR-M-247-9.76C 1150°C 1.00hr CYCLES 100.00hr TEST 2.294mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>

SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $a_0 = 8.10A$ .  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 HfO<sub>2</sub>  
 NiO

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $a_0 = 8.25A$ .  
 TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

N1 BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-247 (JET SHAPES)

1150°C

1.00hr CYCLES

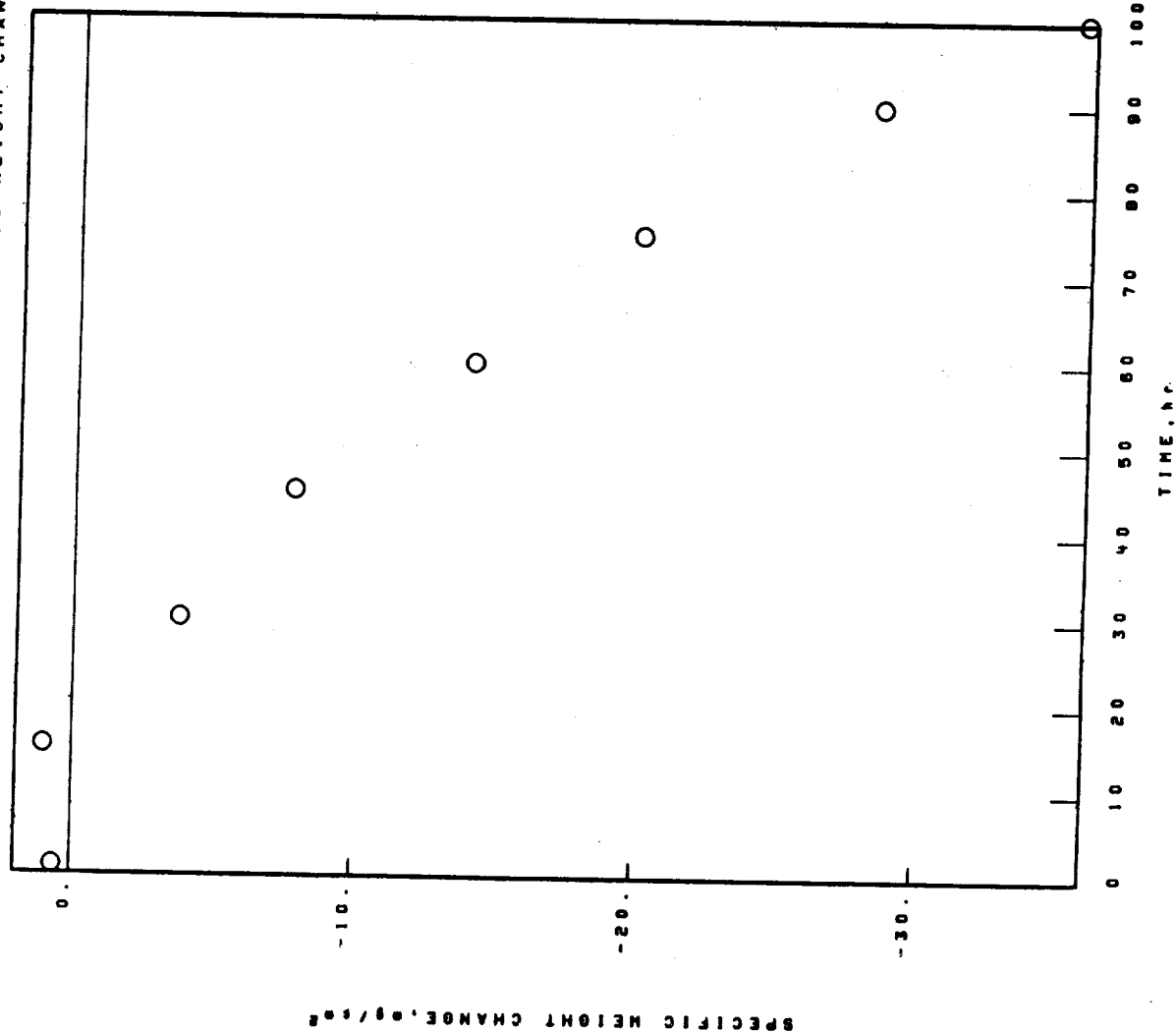
100.00hr TEST

2.292mm THICK

STATIC AIR

02-04-044-656-2

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.61  
1.01  
-3.77  
-7.80  
-14.14  
-20.04  
-28.48  
-35.68



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-044-656-2  
 MAR-M-247 (JET SHAPES) 1150°C 1.00hr CYCLES 100.00hr TEST 2.292mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 TRI(RUTILE).4(110)53.30A.

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL. a<sub>0</sub>=8.10A.  
 SPINEL. a<sub>0</sub>=8.25A.  
 HfO<sub>2</sub>

100 hr

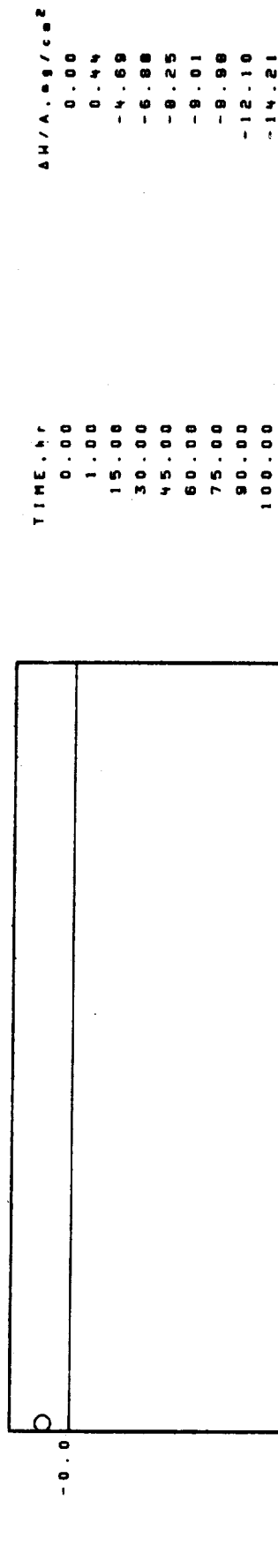
COLLECTED SPALL

NiO  
 SPINEL. a<sub>0</sub>=8.25A.  
 TRI(RUTILE).4(110)53.30A.  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 SPINEL. a<sub>0</sub>=8.10A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 MAR-M-247(DURADYNE)  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.325mm THICK  
 02-04-052-658-3  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-052-656-3  
 MAR-M-247 (DURADYNE) 1150°C 1.00hr CYCLES 100.00hr TEST 2.325mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

WfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. #0-8.10A.

Al<sub>2</sub>O<sub>3</sub>

WfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

WfO

SPINEL. #0-8.20A.

NI(W.M.)O<sub>4</sub> TYPE 1

WfO<sub>2</sub>

SPINEL. #0-8.10A.

NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM MAR-M-247-9.76C.

1100°C

1.00hr CYCLES

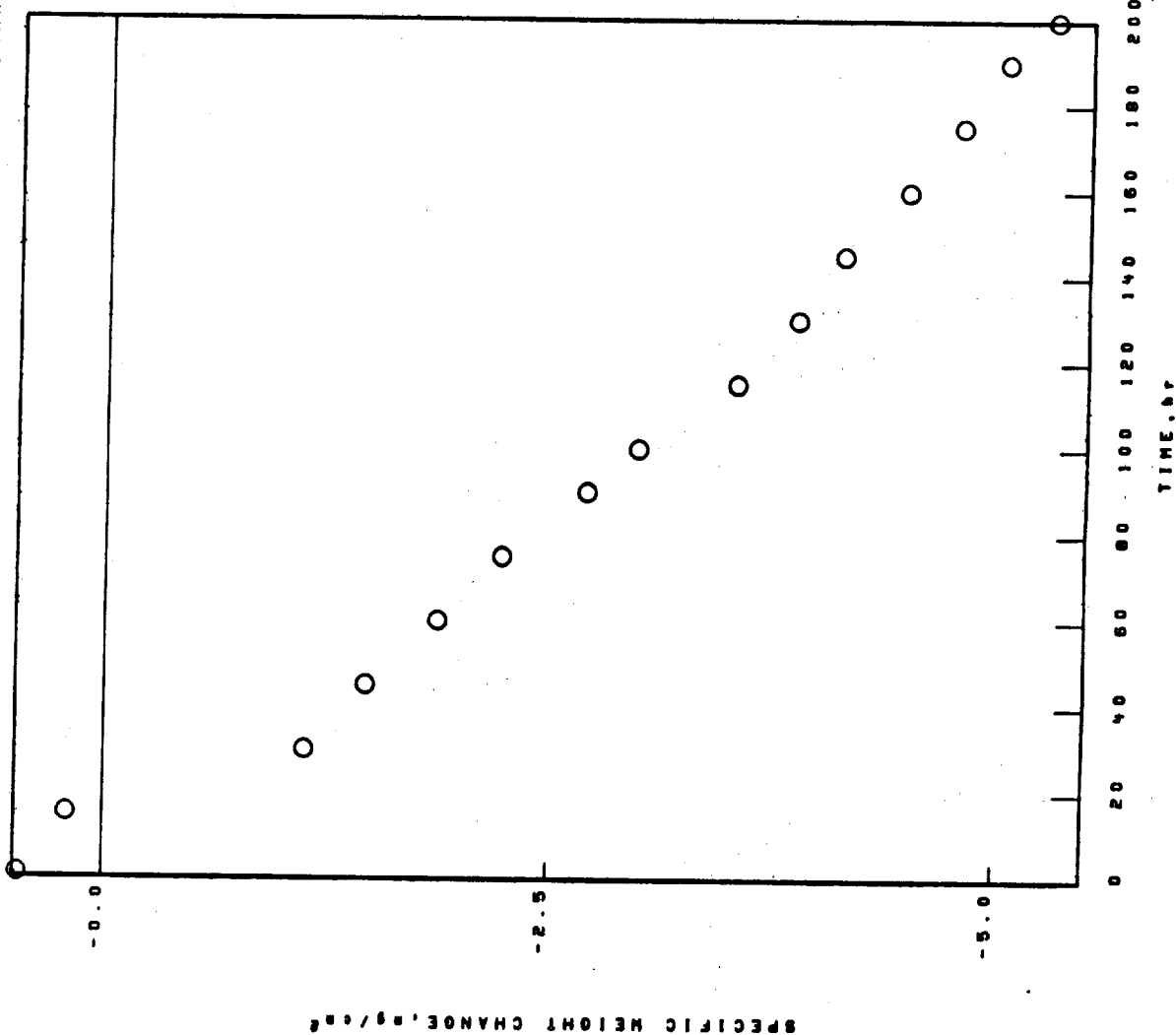
200.00hr TEST

2.304mm THICK

STATIC AIR

02-09-108-453-5

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔM/A, mg/cm²
0.00	0.00
1.00	0.47
15.00	0.21
30.00	-1.13
45.00	-1.47
60.00	-1.87
75.00	-2.23
90.00	-2.70
100.00	-2.90
115.00	-3.53
130.00	-3.87
145.00	-4.12
160.00	-4.48
175.00	-4.78
190.00	-5.03
200.00	-5.30

NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-108-453-5  
 COSAM MAR-W-247-9.76C. 1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL  
 1 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -8.25A.  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)S3.30A.  
 HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

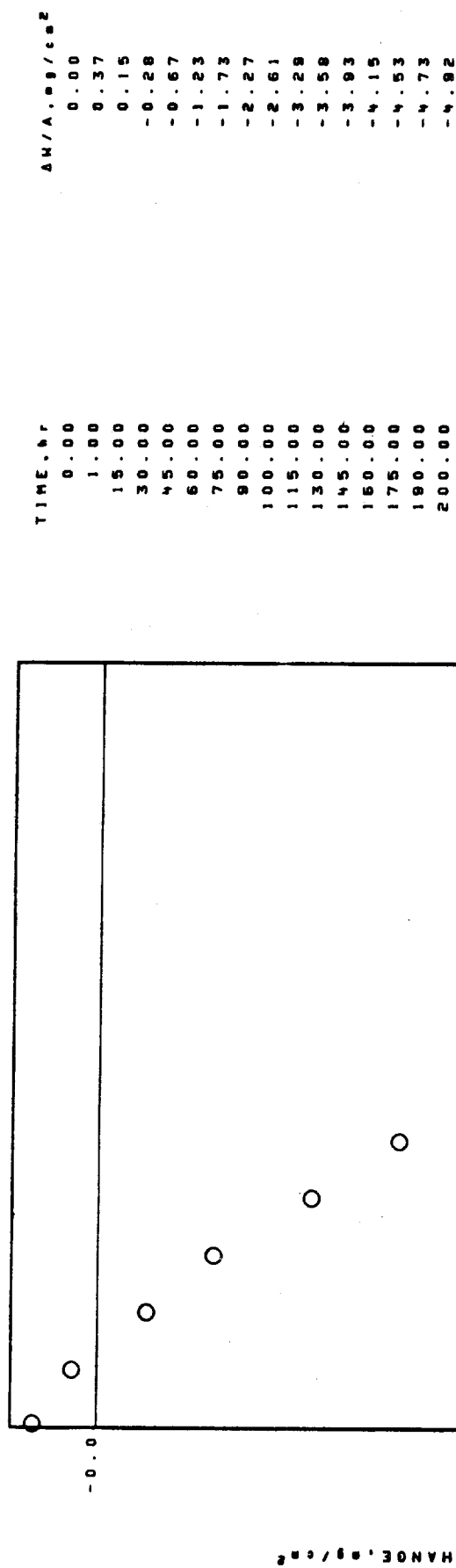
100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 NiO  
 TRI(RUTILE).4(110)S3.30A.  
 HfO<sub>2</sub>  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 100 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).4(110)S3.30A.  
 HfO<sub>2</sub>  
 SPINEL.  $\theta$ -8.10A.

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>  
 TRI(RUTILE).4(110)S3.30A.  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -8.10A.  
 TRI(RUTILE).4(110)S3.30A.  
 Ni(W.M.)<sub>10</sub>, TYPE 1  
 HfO<sub>2</sub>  
 SPINEL.  $\theta$ -8.30A.  
 FACE CENTERED CUBIC MATRIX

NI BASE  
 COSAM MAR-M-247-9.76C  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.300mm THICK  
 02-09-100-481-3  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM MAR-M-247-9.76C<sub>0</sub> 1100°C 1.00hr CYCLES 200.00hr TEST 2.300mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.25A.

HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

HfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

NI(W.M.)10, TYPE 1

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

NI

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

SPINEL. 90-8.20A.

NI

TRI(RUTILE).4(110)53.30A.

SPINEL. 90-8.05A.

Cr<sub>2</sub>O<sub>3</sub>

HfO<sub>2</sub>

200 hr

COLLECTED SPALL

NI

SPINEL. 90-8.30A.

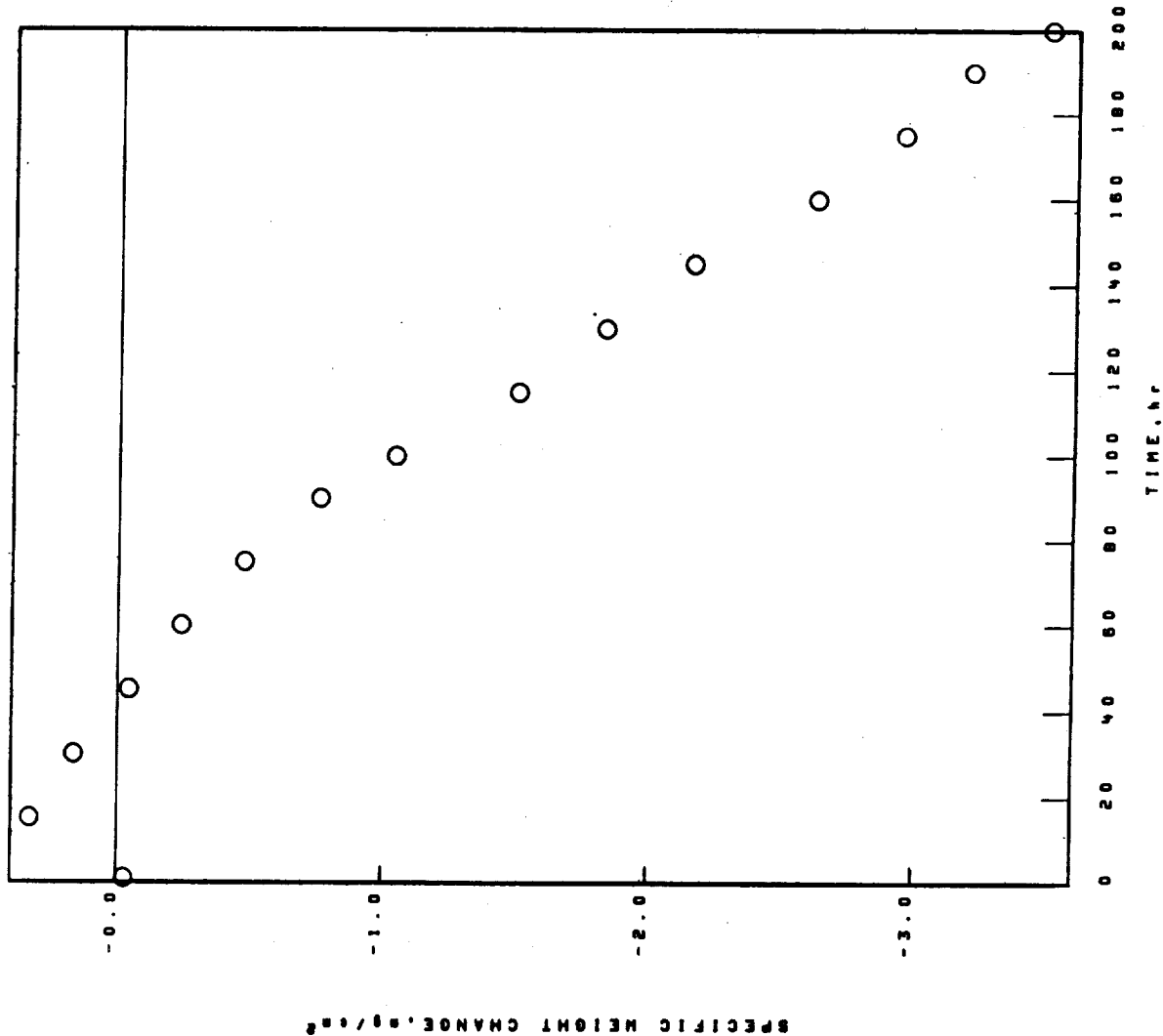
TRI(RUTILE).4(110)53.30A.

SPINEL. 90-8.10A.

HfO<sub>2</sub>

NI BASE  
 COSAM MAR-M-247-9.76C  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.292mm THICK  
 02-09-108-657-1  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA





## EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST 2.292

CYCLES 200.00hr

1100°C

COSAM MAR-M-247-9.76C°

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

HfO<sub>2</sub>

TRI(RUTILE).4(110)S3.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)S3.30A.

NiO

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)S3.30A.

NiO

HfO<sub>2</sub>

SPINEL. 90-8.25A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.20A.

SPINEL. 90-8.05A.

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O, TYPE 1

200 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.25A.

TRI(RUTILE).4(110)S3.30A.

Ni(W.M.)O, TYPE 1

SPINEL. 90-8.10A.

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-247 (JET SHAPES)

1100°C

1.00hr CYCLES

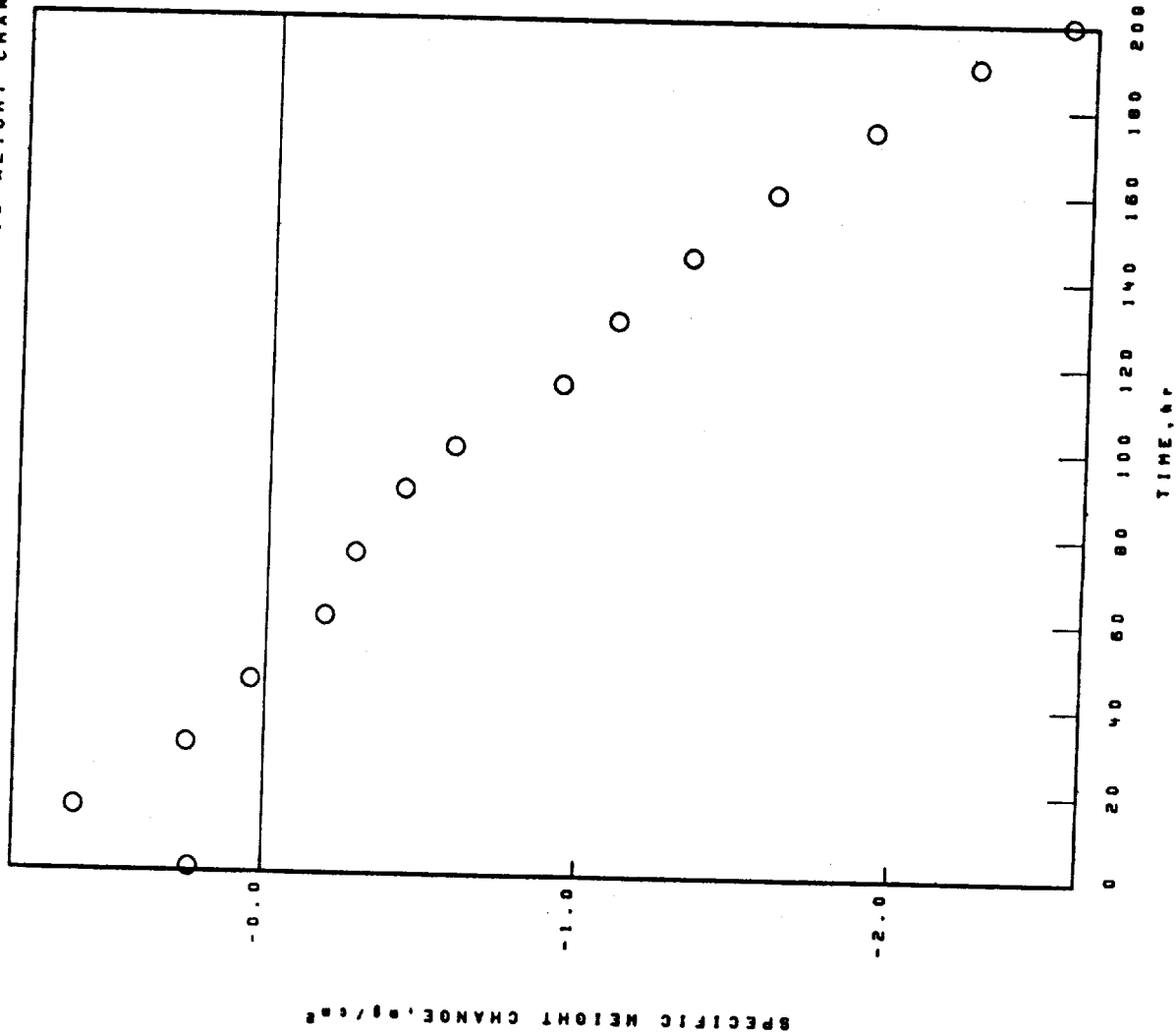
200.00hr TEST

2.294mm THICK

STATIC AIR

02-04-044-657-2

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cm²  
0.00  
0.23  
0.60  
0.25  
0.05  
-0.18  
-0.28  
-0.43  
-0.58  
-0.93  
-1.10  
-1.33  
-1.58  
-1.90  
-2.23  
-2.52

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 HAR-M-247 (JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.294mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)53.30A.HfO<sub>2</sub>Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL.  $\theta$ -8.10A.SPINEL.  $\theta$ -8.25A.Al<sub>2</sub>O<sub>3</sub>CoMoO<sub>4</sub> (25-1434)

NiO

SPINEL.  $\theta$ -8.25A.

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL.  $\theta$ -8.10A.TRI(RUTILE).  $\theta$ (110)53.30A.

Ni(Mo)O, TYPE I

HfO<sub>2</sub>

NiO

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL.  $\theta$ -8.20A.SPINEL.  $\theta$ -8.05A.TRI(RUTILE).  $\theta$ (110)53.30A.

Ni(Mo)O, TYPE I

200 hr

## COLLECTED SPALL

NiO

SPINEL.  $\theta$ -8.25A.TRI(RUTILE).  $\theta$ (110)53.30A.

Ni(Mo)O, TYPE I

SPINEL.  $\theta$ -8.10A.

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

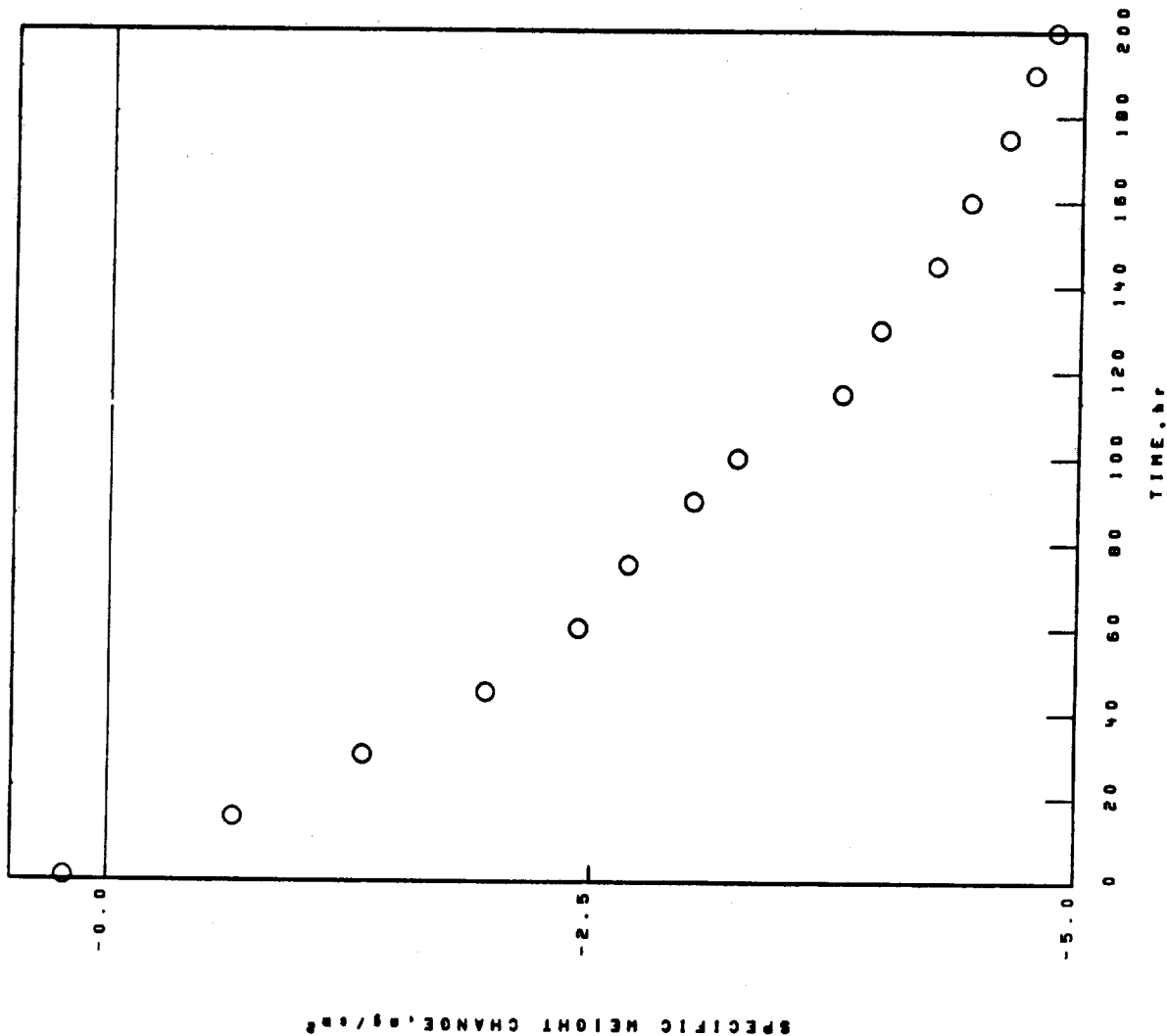
02-04-052-657-3

MAR-M-247(DURADYNE)

1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.22
15.00	-0.65
30.00	-1.32
45.00	-1.95
60.00	-2.43
75.00	-2.68
90.00	-3.01
100.00	-3.24
115.00	-3.78
130.00	-3.97
145.00	-4.25
160.00	-4.43
175.00	-4.62
190.00	-4.74
200.00	-4.85

## NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

WAR-M-247(DURADYNE) 1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.10A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

NiO

Ni(W.M.)O, TYPE 1

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

NiO

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.20A.

SPINEL. 90-8.05A.

TRI(RUTILE).4(110)53.30A.

Ni(W.M.)O, TYPE 1

200 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.25A.

TRI(RUTILE).4(110)53.30A.

Ni(W.M.)O, TYPE 1

SPINEL. 90-8.10A.

NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM MAR-M-247-9.76C.

1000°C

1.00hr CYCLES

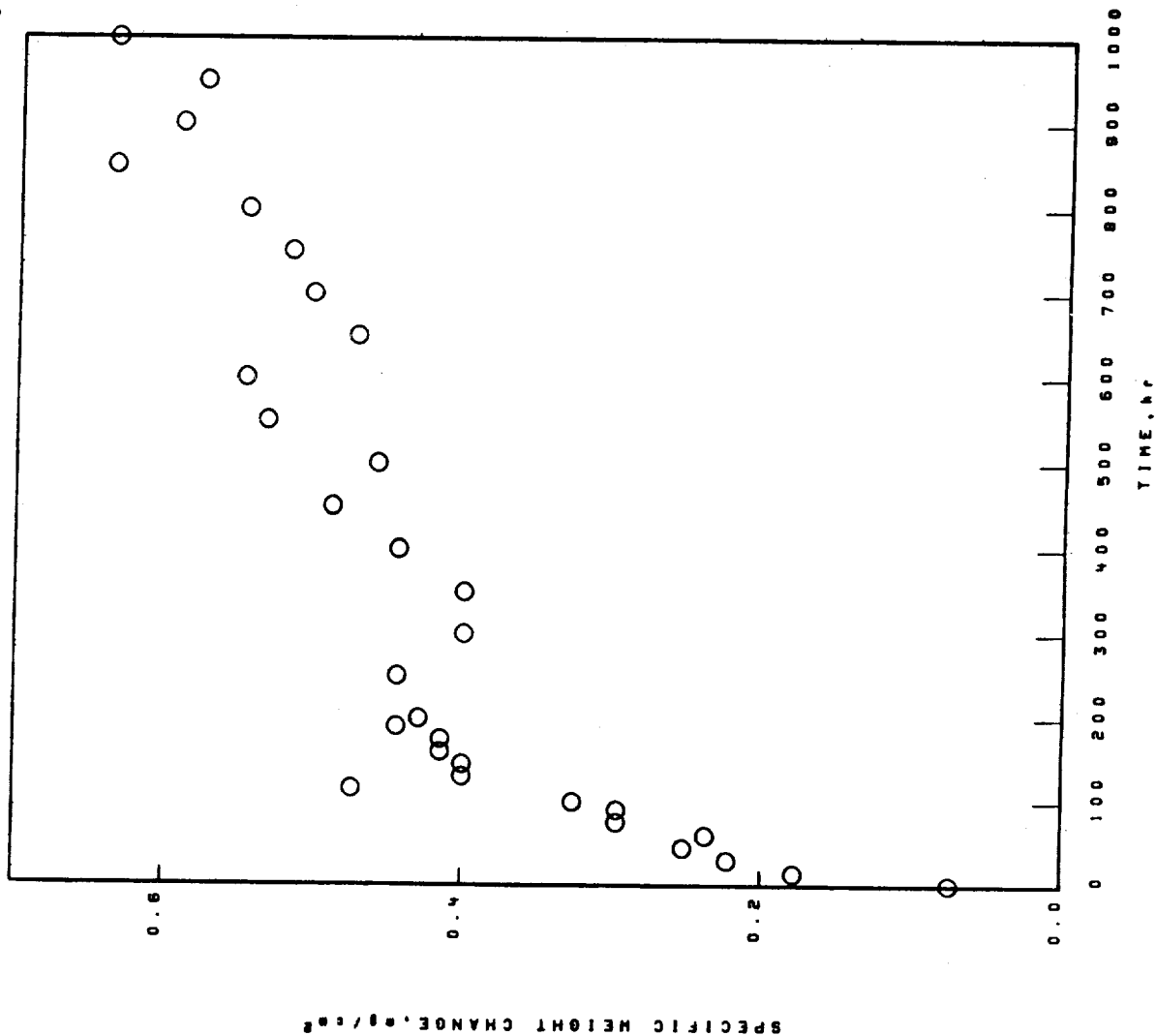
TEST

2.296mm THICK

STATIC AIR

02-09-108-452-5

SPECIFIC WEIGHT CHANGE DATA



NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-108-452-5  
 COSAM MAR-M-247-9.76C 1000°C 1.00hr CYCLES 1000.00hr TEST 2.296mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 HfO<sub>2</sub>  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 100 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>  
 TRI(RUTILE).d(110)13.30A.  
 SPINEL.  $\theta_0$ =8.25A.  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 200 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta_0$ =8.10A.  
 HfO<sub>2</sub>  
 TRI(RUTILE).d(110)13.30A.  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 500 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>  
 TRI(RUTILE).d(110)13.30A.  
 SPINEL.  $\theta_0$ =8.10A.  
 TRI(RUTILE).d(110)13.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 1000 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 COLLECTED SPALL  
 NiO

NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM WAR-M-247-8.78C.

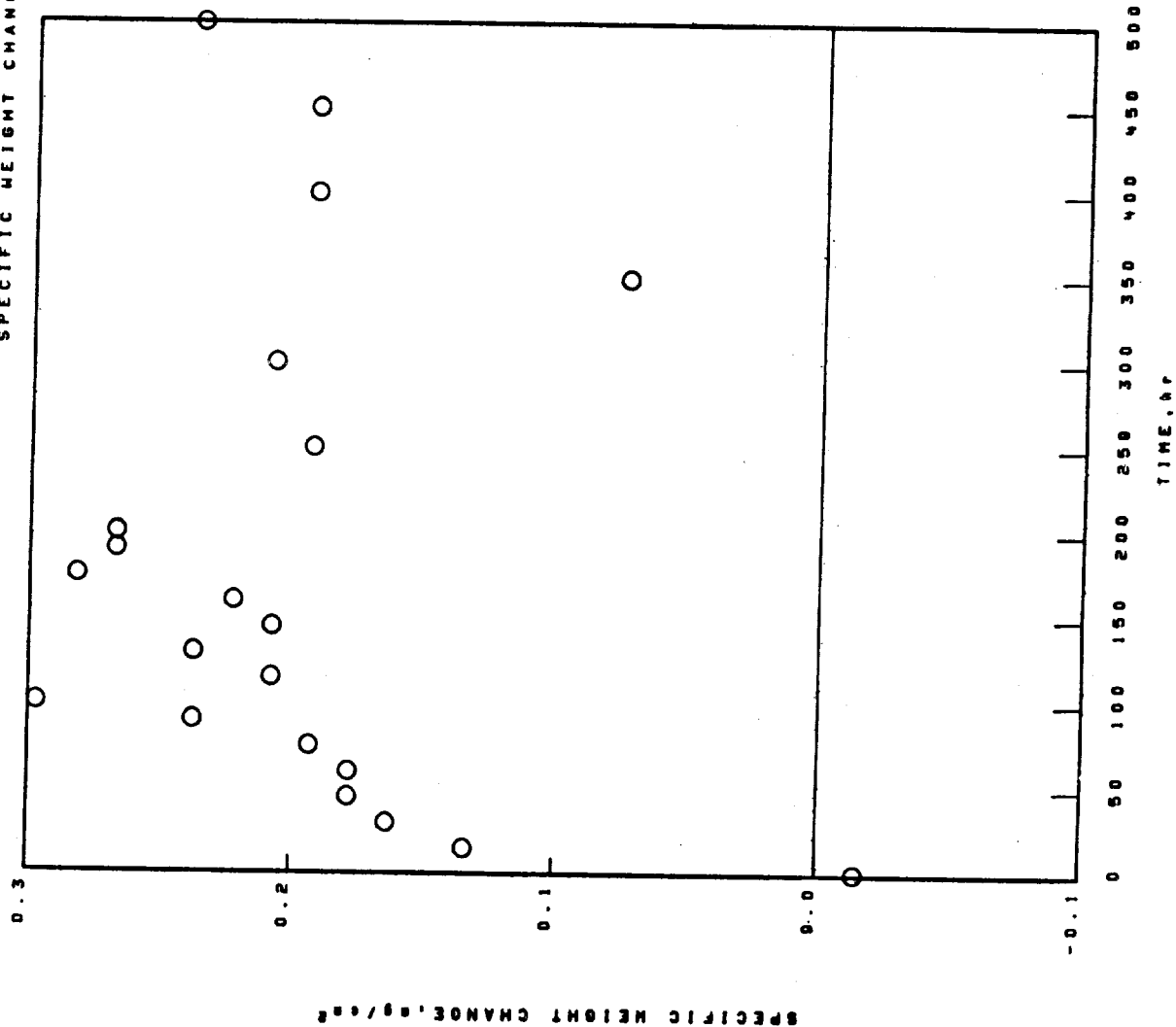
1000°C 1.00hr CYCLES

500.00hr TEST 2.299mm THICK

STATIC AIR

02-09-108-480-3

SPECIFIC WEIGHT CHANGE DATA





## EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

500.00hr TEST

1.00hr CYCLES

1000°C

COSAM MAR-M-247-8.76C

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

HfO<sub>2</sub>Al<sub>2</sub>O<sub>3</sub>Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

100 hr

## STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

TRI(RUTILE).4(110)53.30A.

SPINEL. 80-8.30A.

SPINEL. 80-8.10A.

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

SPINEL. 80-8.15A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

NO SIGNIFICANT SPALL OBSERVED

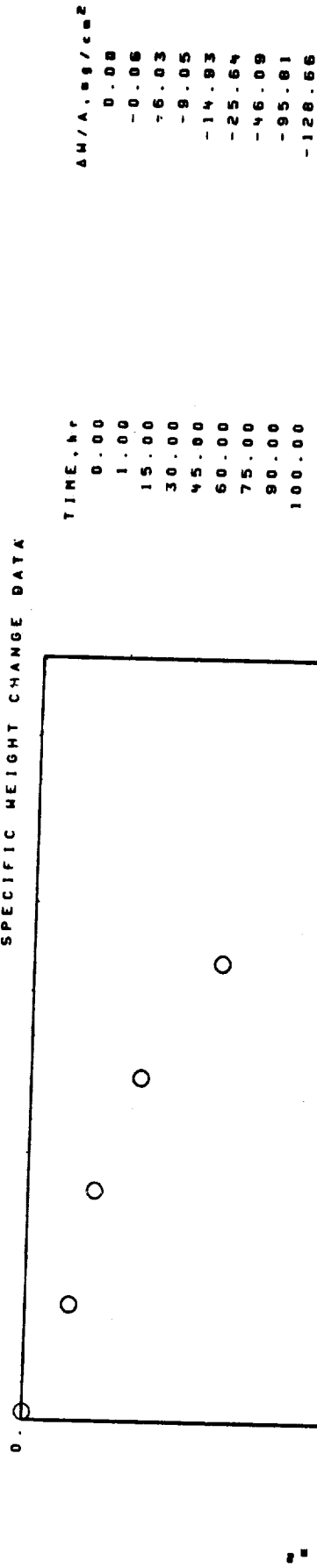
NI BASE  
MAR-M-421

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-013-322-1

1150°C 1.00hr CYCLES 100.00hr TEST 2.181mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

THICK STATIC AIR

TEST 2.181

1150°C 1.00hr CYCLES 100.00hr

TEST

THICK

STATIC AIR

MAR-M-421

## X-RAY DIFFRACTION DATA

SURFACE  
100 hr  
STANDARD SURFACE  
NIO  
SPINEL. #0-8.30A.  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.

SPALL  
100 hr  
COLLECTED SPALL  
NIO  
SPINEL. #0-8.30A.  
Ni(M.M.)O<sub>4</sub> TYPE 1  
TRI(RUTILE).4(110)53.30A.  
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES. d VALUES  
2.76A.

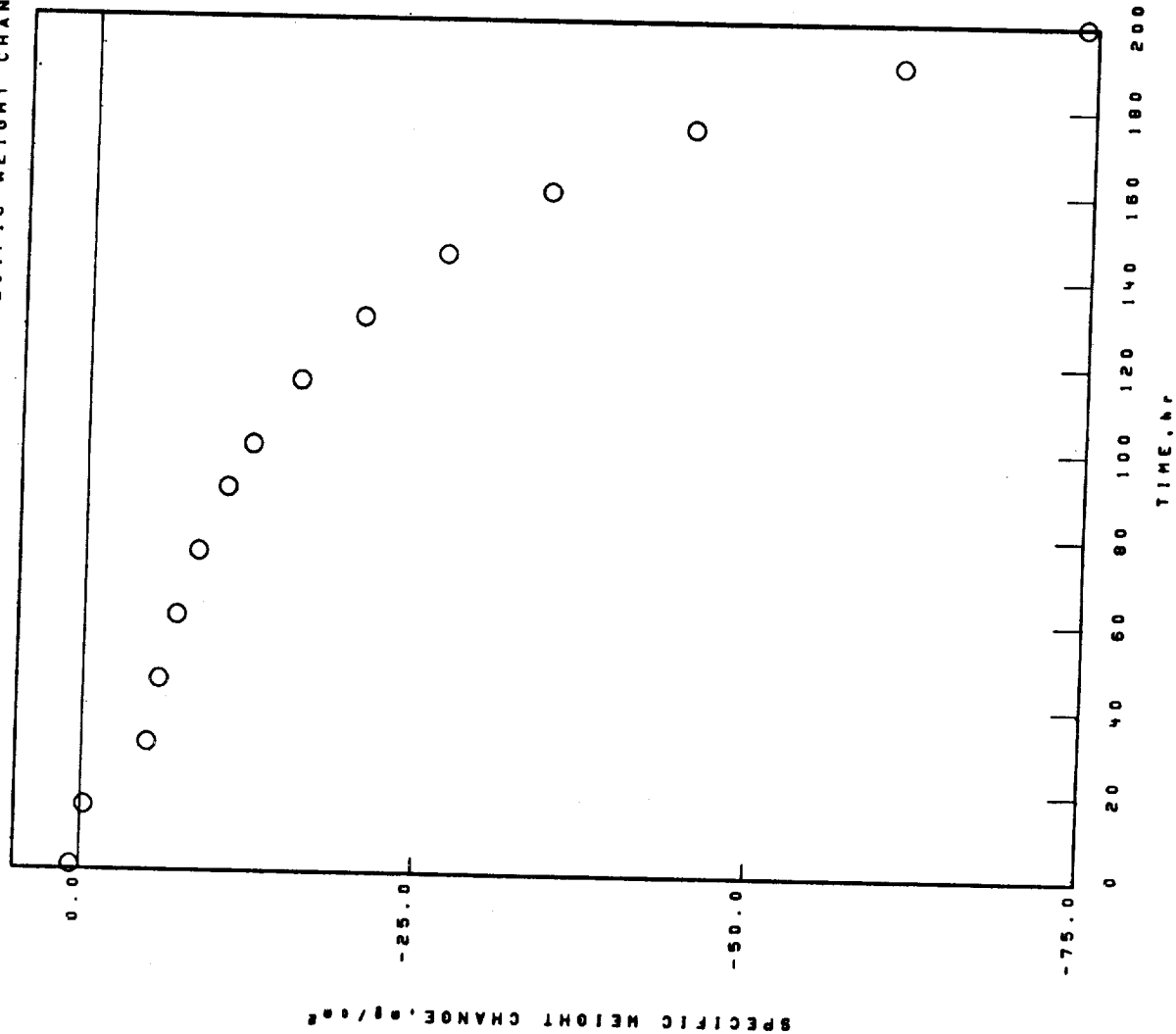
# NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

MAR-M-421

02-04-013-325-1

1100°C 1.00hr CYCLES 200.00hr TEST 2.183 THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, g/cc²  
0.00  
0.69  
-0.27  
-4.90  
-5.70  
-6.90  
-8.46  
-10.54  
-12.35  
-15.85  
-20.49  
-26.58  
-34.25  
-44.94  
-60.43  
-74.11

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-013-325-1  
 MAR-M-421 1100°C 1.00hr CYCLES 200.00hr TEST 2.183mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta_0 = 8.30A$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).  $\theta(110) 53.30A$ .  
 Ni(W.M.)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX

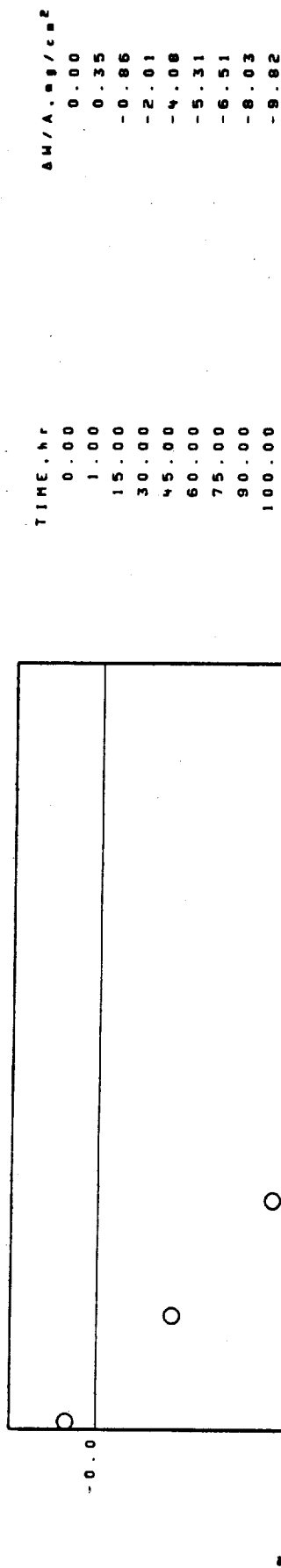
SPALL

200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta_0 = 8.25A$ .  
 Ni(W.M.)O<sub>4</sub> TYPE 1  
 TRI(RUTILE).  $\theta(110) 53.30A$ .  
 Cr<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES, 4 VALUES  
 2.72A.

NT BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-472-4  
 NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.354mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-021-472-4  
 NASA-TRW-VI-A                      1150°C                      1.00hr CYCLES                      100.00hr TEST                      2.354mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 TRI(RUTILE).d(110)3.30A.  
 SPINEL.  $\theta_0$ =8.15A.  
 Al<sub>2</sub>O<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>

SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0$ =8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).d(110)3.30A.  
 HfO<sub>2</sub>  
 ZrO<sub>2</sub>

100 hr  
 COLLECTED SPALL  
 HfO  
 TRI(RUTILE).d(110)3.30A.  
 SPINEL.  $\theta_0$ =8.20A.

FACE CENTERED CUBIC MATRIX

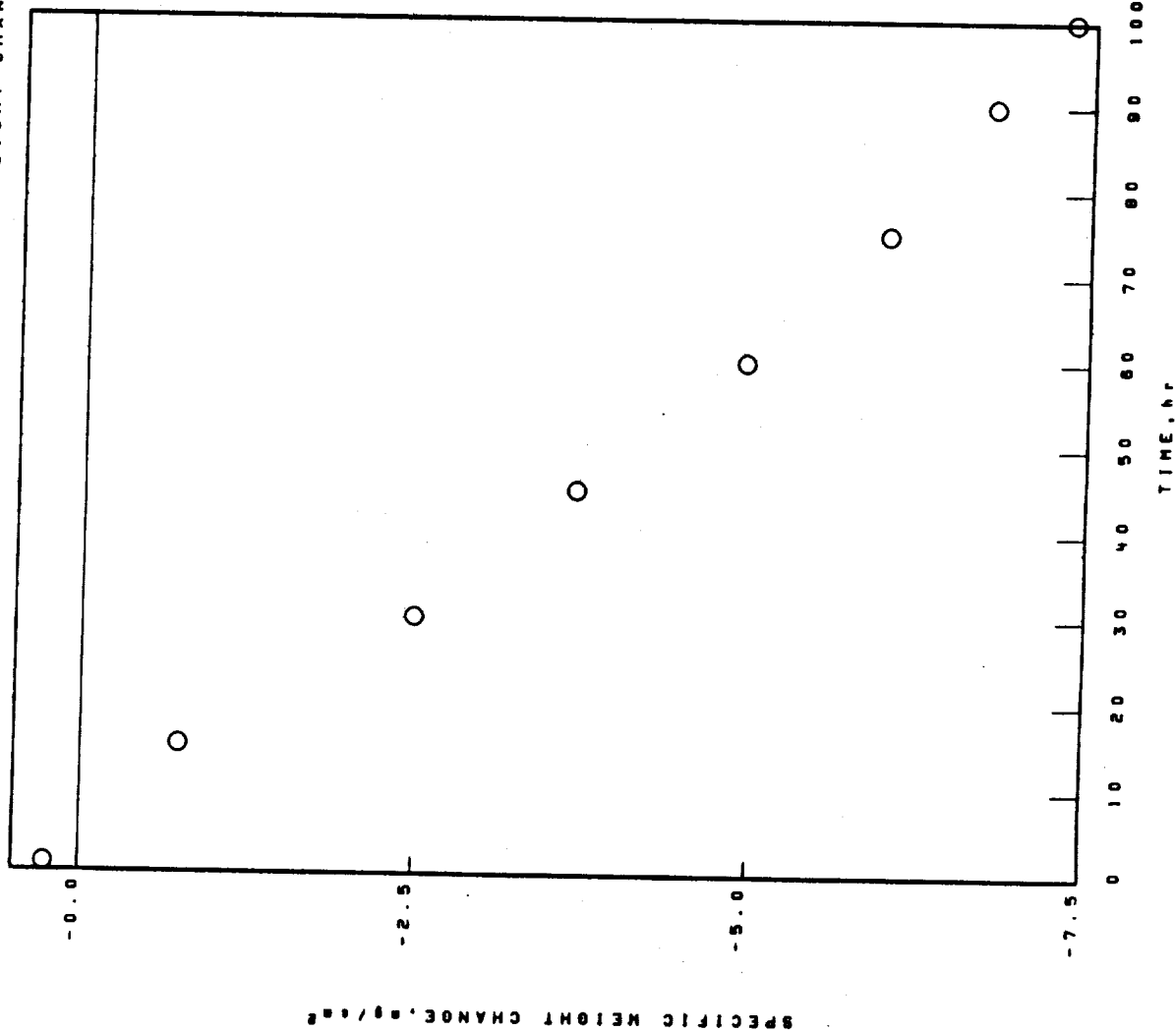
NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-050-658-6

TRW-V1-A-MOD.

1150°C 1.00hr CYCLES 100.00hr TEST 2.327mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
0.26  
-0.73  
-2.48  
-3.69  
-4.94  
-5.99  
-6.77  
-7.35



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

1.00hr CYCLES

1150°C

100.00hr

TRW-VI-A-MOD.

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

TRI(RUTILE).4(110)53.30A.

SPINEL. 90-8.10A.

HfO<sub>2</sub>

100 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

SPINEL. 90-8.25A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

TRI(RUTILE).4(110)53.30A.

SPINEL. 90-8.10A.

SPINEL. 90-8.25A.

NI BASE

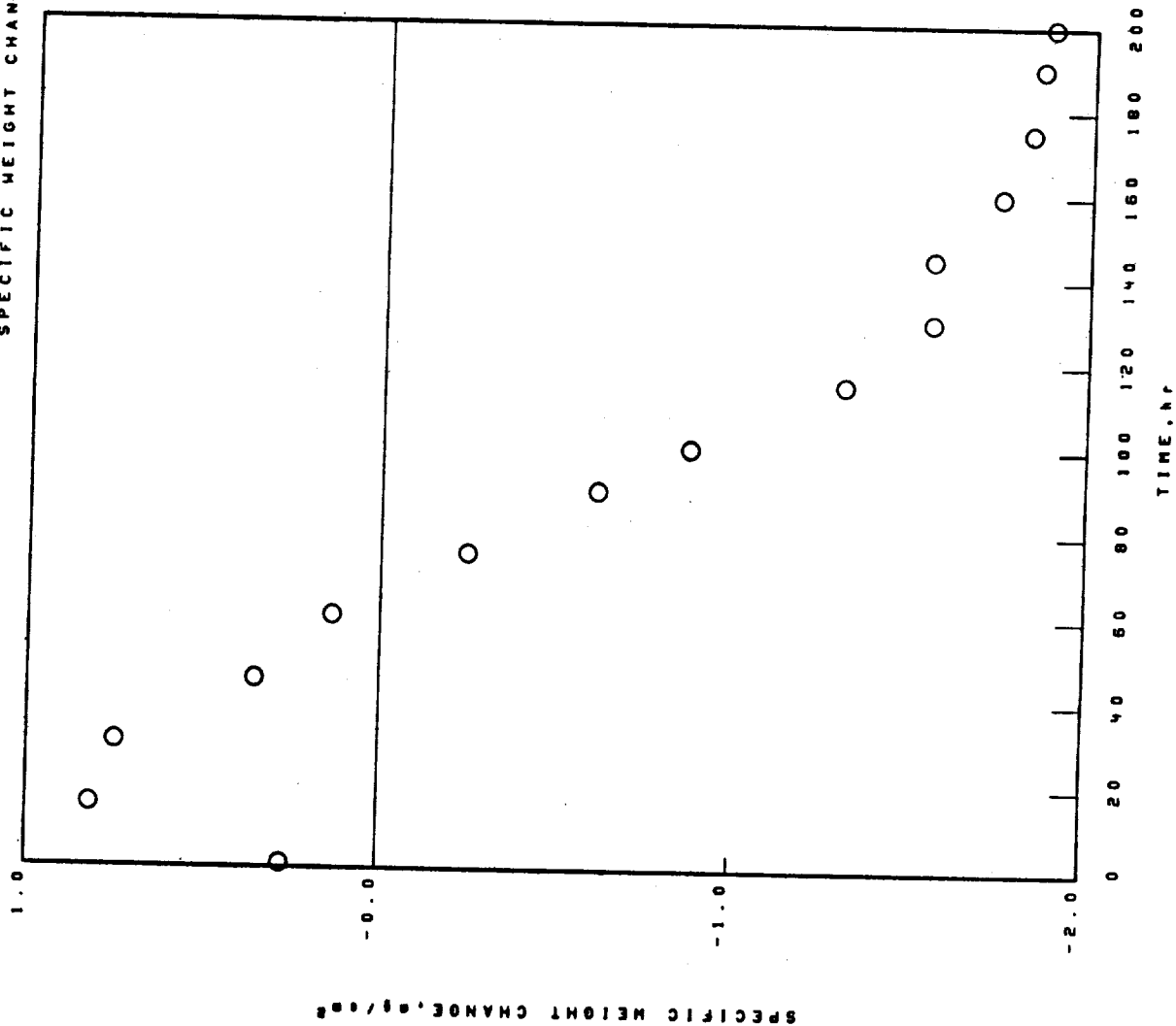
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NASA-TRW-VI-A

02-04-021-473-4

1100°C 1.00hr CYCLES 200.00hr TEST 2.349mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

N1 BASE

STATIC AIR

THICK

TEST

1.00hr CYCLES

1100°C

NASA-TRM-VI-A

200.00hr

2.349mm

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

TRI(RUTILE).4(110)53.30A.

Cr<sub>2</sub>O<sub>3</sub>Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 8-8.10A.

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL. 8-8.10A.

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>HfO<sub>2</sub>

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

TRI(RUTILE).4(110)53.30A.

NiO

SPINEL. 8-8.10A.

SPINEL. 8-8.20A.

200 hr

## COLLECTED SPALL

Al<sub>2</sub>O<sub>3</sub>

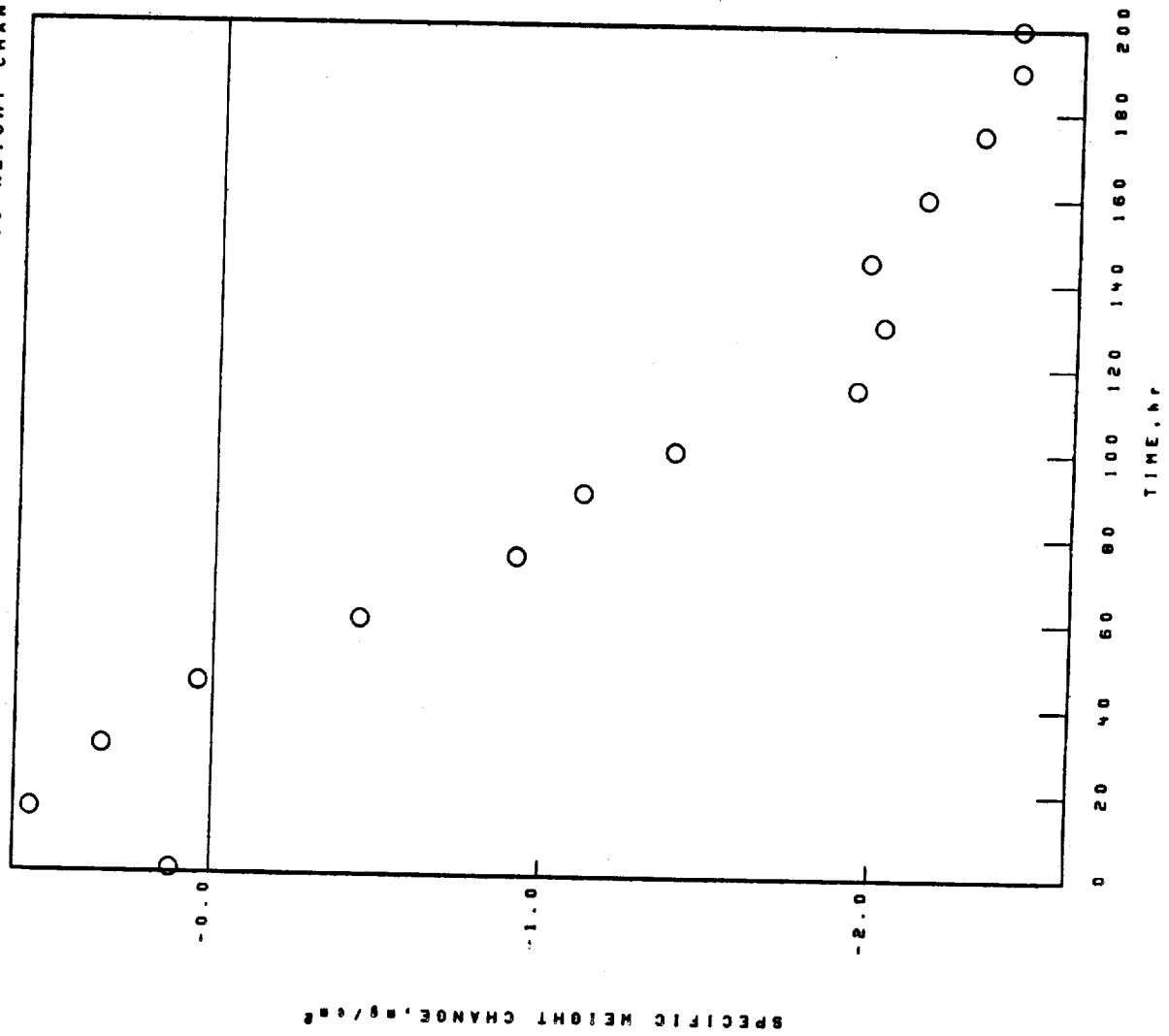
NiO

SPINEL. 8-8.05A.

SPINEL. 8-8.20A.

N1 BASE  
 TRW-V1-A-MOD.  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.326mm THICK STATIC AIR  
 02-04-050-659-6

SPECIFIC WEIGHT CHANGE DATA



02-04-050-659-6

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

TRM-VI-A-MOD. 1100°C 1.00hr CYCLES 200.00hr TEST 2.326mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL

1 hr 1 hr

STANDARD SURFACE NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

100 hr 100 hr

STANDARD SURFACE COLLECTED SPALL

SPINEL. 90-8-10A. Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A. SPINEL. 90-8-25A.

Al<sub>2</sub>O<sub>3</sub>

NiO

FACE CENTERED CUBIC MATRIX

200 hr 200 hr

STANDARD SURFACE PROBABLE CROSS-SPALL

SPINEL. 90-8-10A. NiO

TRI(RUTILE).4(110)53.30A. TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub> SPINEL. 90-8-30A.

NiO Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

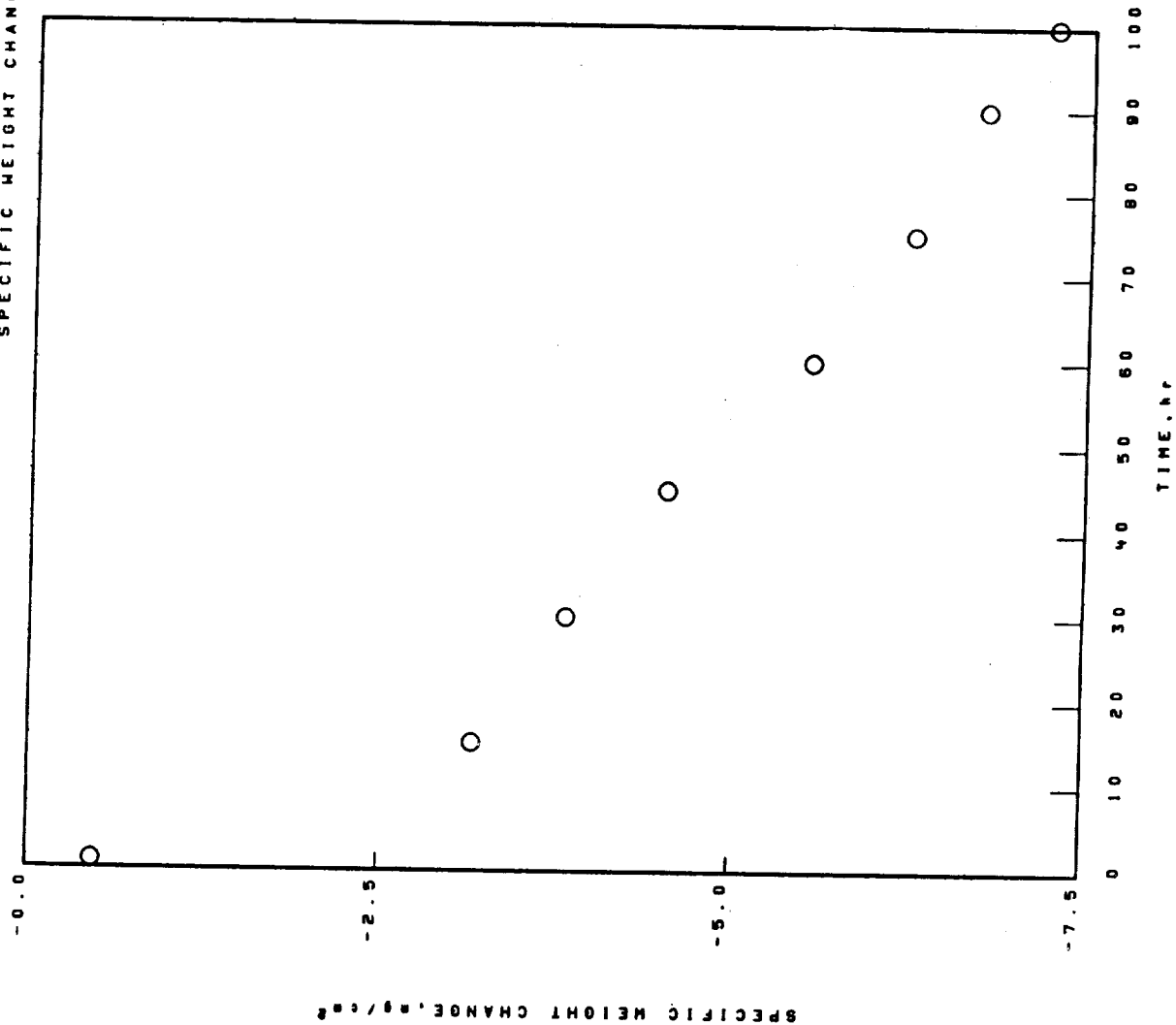
NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-033-663-6

COSAM NIMONIC-115-15.C.

1150°C 1.00hr CYCLES 100.00hr TEST 2.249mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
-0.47  
-3.16  
-3.82  
-4.53  
-5.54  
-6.25  
-6.75  
-7.24

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-033-663-6  
 COSAM NIMONIC-115-15.C 1150°C 1.00hr CYCLES 100.00hr TEST 2.249mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
1 hr	1 hr
STANDARD SURFACE	COLLECTED SPALL
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
SPINEL. $\theta$ = 8.20A.	(Ni.Co.Fe)TiO <sub>3</sub>
TRI(RUTILE).4(110)53.30A.	SPINEL. $\theta$ = 8.20A.
(Ni.Co.Fe)TiO <sub>3</sub>	TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$  = 8.10A.  
 TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 SPINEL.  $\theta$  = 8.25A.

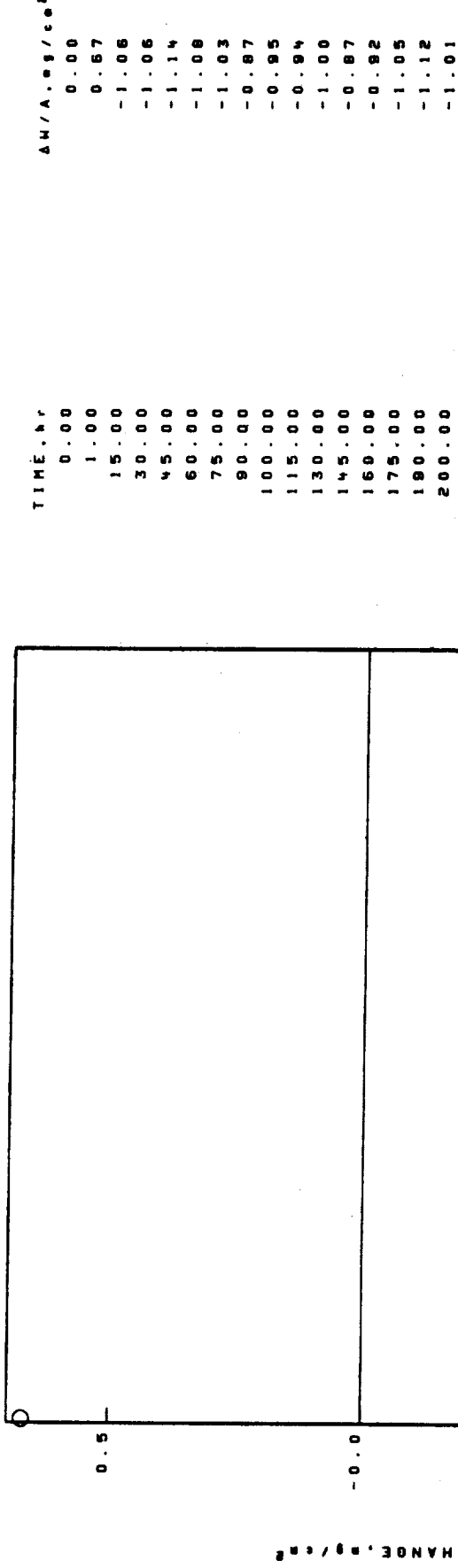
NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-033-664-6

COSAM NIMONIC-115-15.C.

1100°C 1.00hr CYCLES 200.00hr TEST 2.221mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM NIMONIC-115-15.C. 1100°C 1.00hr CYCLES 200.00hr TEST 2.221hr THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

SPINEL.  $\theta_0$ =8.20A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ =8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ =8.25A.

(Ni<sub>1</sub>.Co<sub>0</sub>.Fe<sub>0</sub>)TiO<sub>3</sub>

SPINEL.  $\theta_0$ =8.10A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

200 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ =8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ =8.25A.

TRI(RUTILE).4(110)53.30A.

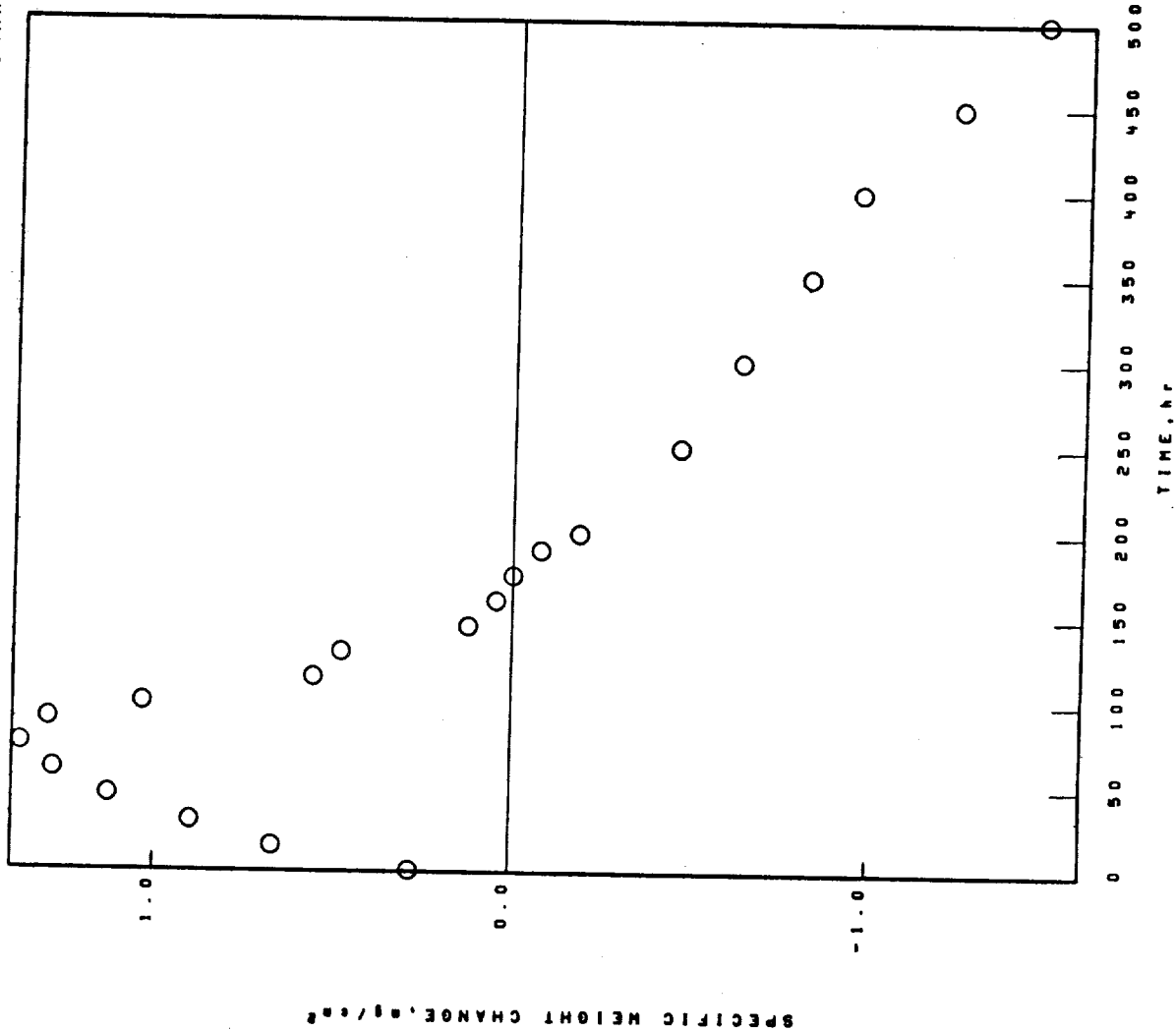
SPINEL.  $\theta_0$ =8.10A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni<sub>1</sub>.Co<sub>0</sub>.Fe<sub>0</sub>)TiO<sub>3</sub>

NI BASE  
 COSAM NIMONIC-115-15.C  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1000°C 1.00hr CYCLES 500.00hr TEST 2.225mm THICK STATIC AIR  
 02-13-033-675-4

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
 0.00  
 1.00  
 15.00  
 30.00  
 45.00  
 60.00  
 75.00  
 90.00  
 100.00  
 115.00  
 130.00  
 145.00  
 160.00  
 175.00  
 190.00  
 200.00  
 250.00  
 300.00  
 350.00  
 400.00  
 450.00  
 500.00

ΔM/A, g/cm²  
 0.00  
 0.28  
 0.67  
 0.90  
 1.13  
 1.28  
 1.38  
 1.30  
 1.04  
 0.56  
 0.48  
 0.12  
 0.05  
 0.00  
 -0.08  
 -0.18  
 -0.46  
 -0.63  
 -0.82  
 -0.96  
 -1.24  
 -1.47

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-033-675-4  
 COSAM NIMONIC-115-15.C 1000°C 1.00hr CYCLES 500.00hr TEST 2.225mm THICK STATIC AIR  
 X-RAY DIFFRACTION DATA

# SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

(Ni.Co.Fe)TiO<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.25A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

(Ni.Co.Fe)TiO<sub>3</sub>

SPINEL. 00-8.25A.

TRI(RUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

500 hr

## STANDARD SURFACE

(Ni.Co.Fe)TiO<sub>3</sub>

SPINEL. 00-8.15A.

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.30A.

TRI(RUTILE).4(110)13.30A.

## FACE CENTERED CUBIC MATRIX

# SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

## COLLECTED SPALL

(Ni.Co.Fe)TiO<sub>3</sub>

SPINEL. 00-8.25A.

NiO

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8.10A.

500 hr

## COLLECTED SPALL

NiO

SPINEL. 00-8.25A.

(Ni.Co.Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

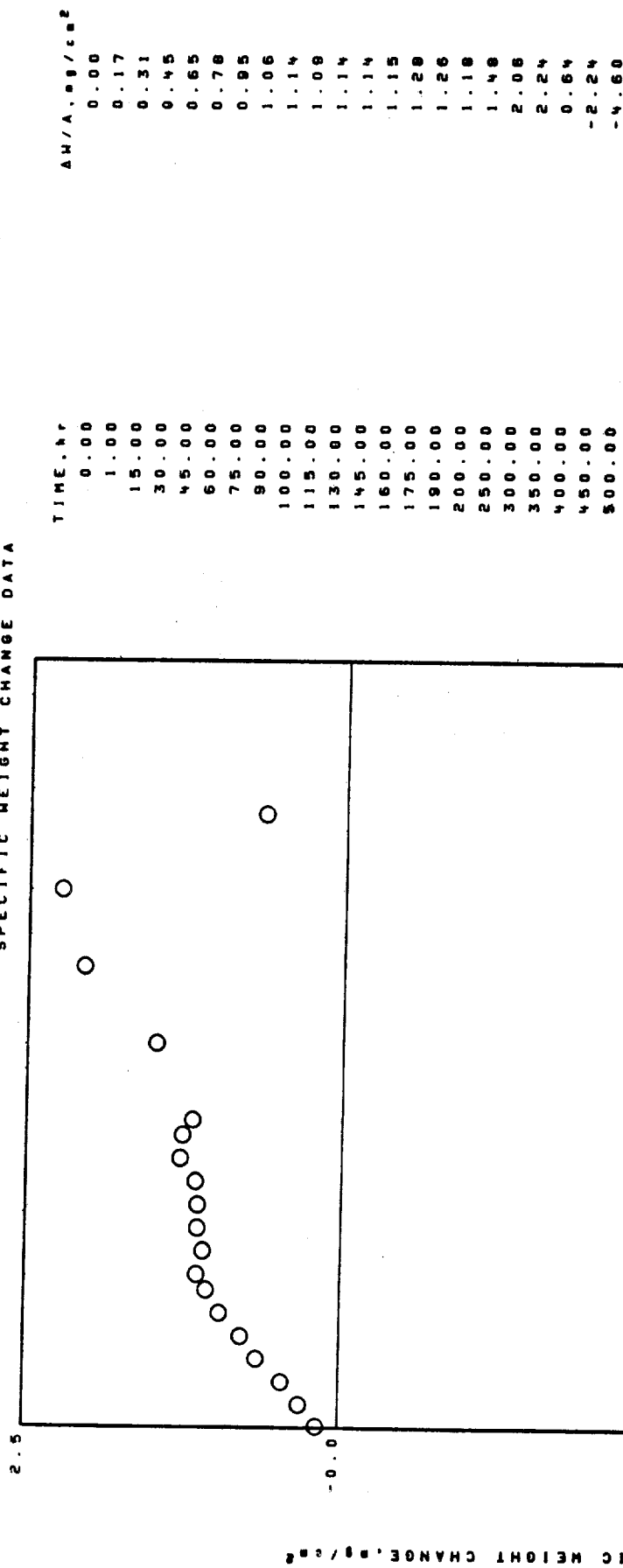
SPINEL. 00-8.10A.

NI BASE  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 COSAM NIMONIC-115-15.C.

02-13-033-675-5

1000°C 1.00hr CYCLES 500.00hr TEST 2.233 THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



02-13-033-675-5

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM NIMONIC-115-15-C 1000°C 1.00hr CYCLES 500.00hr TEST 2.233mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
1 hr  
STANDARD SURFACE  
NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
STANDARD SURFACE  
TRI(RUTILE).4(110)13.30A.

SPINEL. 80-8.10A.

Cr<sub>2</sub>O<sub>3</sub>  
(Ni.Co.Fe)TiO<sub>3</sub>  
Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr  
STANDARD SURFACE  
TRI(RUTILE).4(110)13.30A.

Cr<sub>2</sub>O<sub>3</sub>  
(Ni.Co.Fe)TiO<sub>3</sub>  
SPINEL. 80-8.25A.

FACE CENTERED CUBIC MATRIX

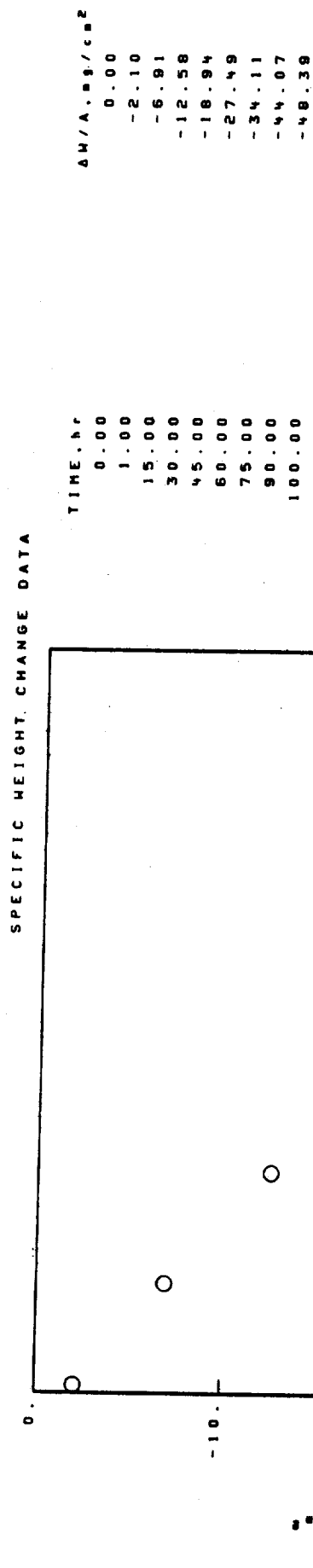
500 hr  
STANDARD SURFACE  
NiO  
SPINEL. 80-8.30A.  
(Ni.Co.Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr  
COLLECTED SPALL  
(Ni.Co.Fe)TiO<sub>3</sub>  
SPINEL. 80-8.25A.  
Cr<sub>2</sub>O<sub>3</sub>  
NiO  
TRI(RUTILE).4(110)13.30A.

500 hr  
COLLECTED SPALL  
NiO  
SPINEL. 80-8.25A.  
Cr<sub>2</sub>O<sub>3</sub>  
(Ni.Co.Fe)TiO<sub>3</sub>  
TRI(RUTILE).4(110)13.30A.  
SPINEL. 80-8.10A.

NI BASE  
 DS-NX-100  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.318mm THICK  
 STATIC AIR  
 02-04-039-414-3



COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

100.00hr

1.00hr CYCLES

1150°C

DS-NX-108

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NIO

SPINEL.  $\theta_0$ -8.05A.

SPALL

100 hr

COLLECTED SPALL

NIO

SPINEL.  $\theta_0$ -8.05A.

UNKNOWN LINES.  $\theta$  VALUES

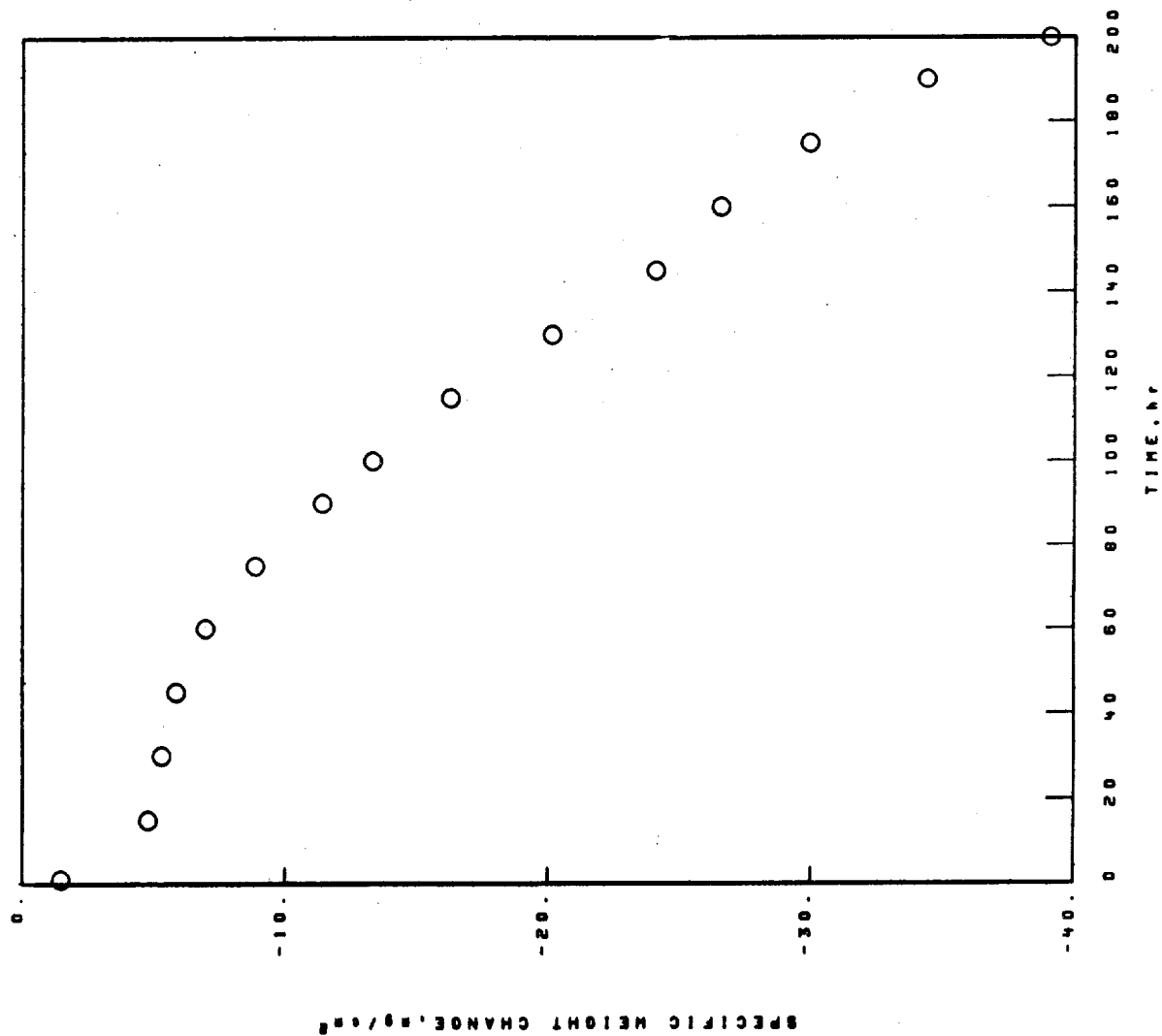
3.09A.

2.51A.

1.59A.

NI BASE  
 NX-100  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR  
 02-04-027-393-2

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-393-2  
 NX-188 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta_0 = 8.05A$ .

SPALL  
 200 hr  
 COLLECTED SPALL  
 SPINEL.  $\theta_0 = 8.30A$ .  
 NiO  
 Ni(W.M.)O, TYPE I

NI BASE

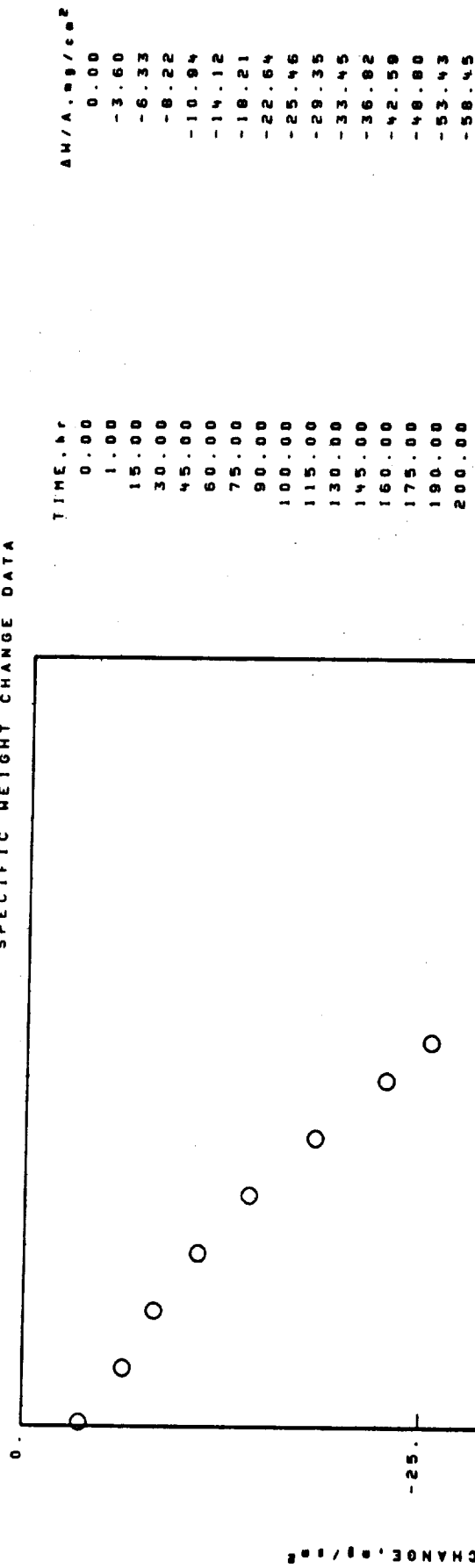
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

DS-NX-189

02-04-039-413-3

1100°C 1.00hr CYCLES 200.00hr TEST 2.316mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

DS-NX-100 1100°C 1.00hr CYCLES 200.00hr TEST 2.316mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
W10	W10
SPINEL. 8-8.05A.	W10, W10, TYPE 2.
Al <sub>2</sub> O <sub>3</sub>	SPINEL. 8-8.05A.
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES. 4 VALUES
	2.50A.

N1 BASE

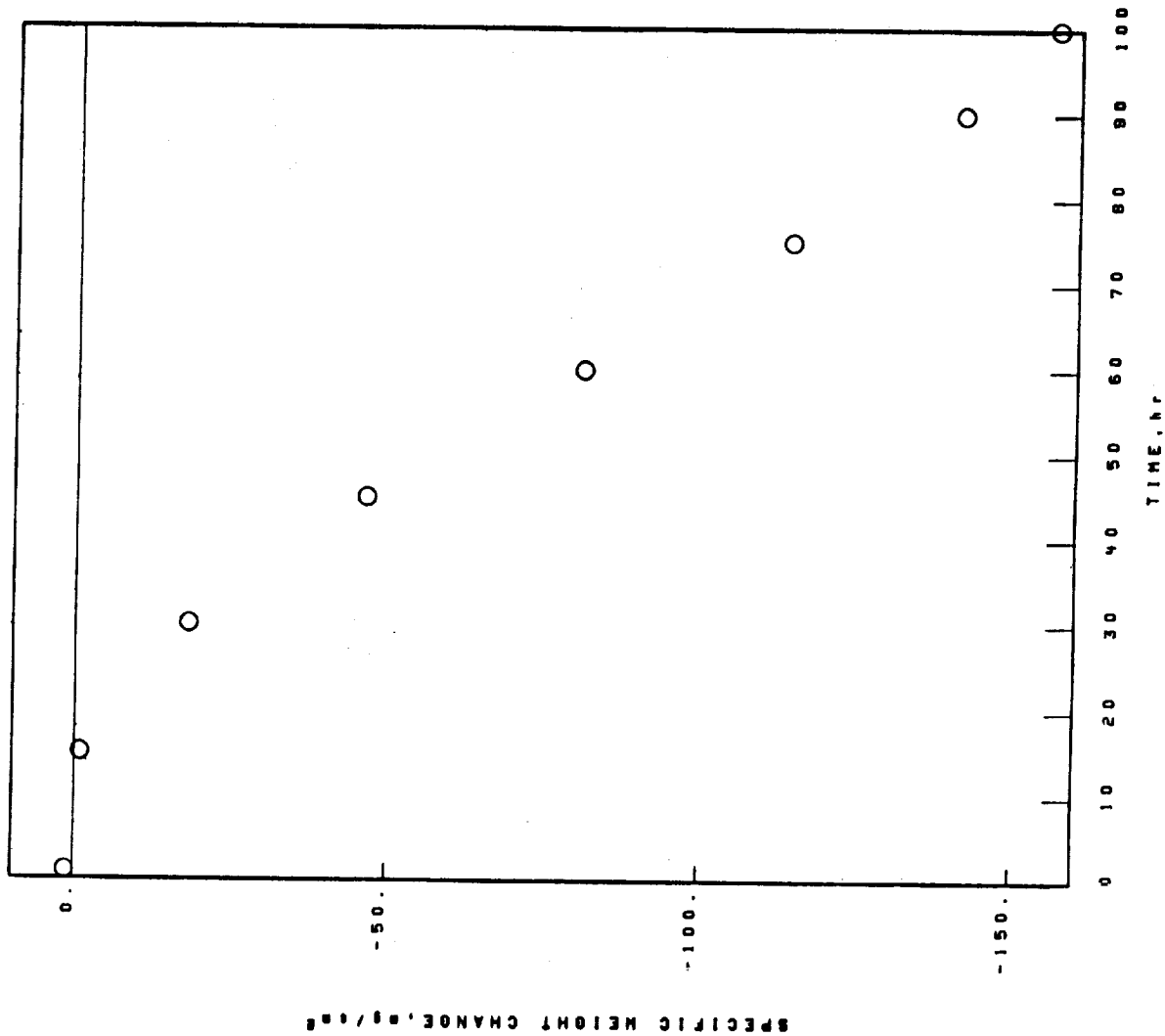
COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-006-100-5

RENE 41

1150°C 1.00hr CYCLES 100.00hr TEST 0.778mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
1.23  
-0.68  
-18.11  
-46.43  
-81.04  
-114.19  
-141.47  
-156.41

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-006-100-5  
 RENE 41 1150°C 1.00hr CYCLES 100.00hr TEST 0.778mm THICK STATIC AIR

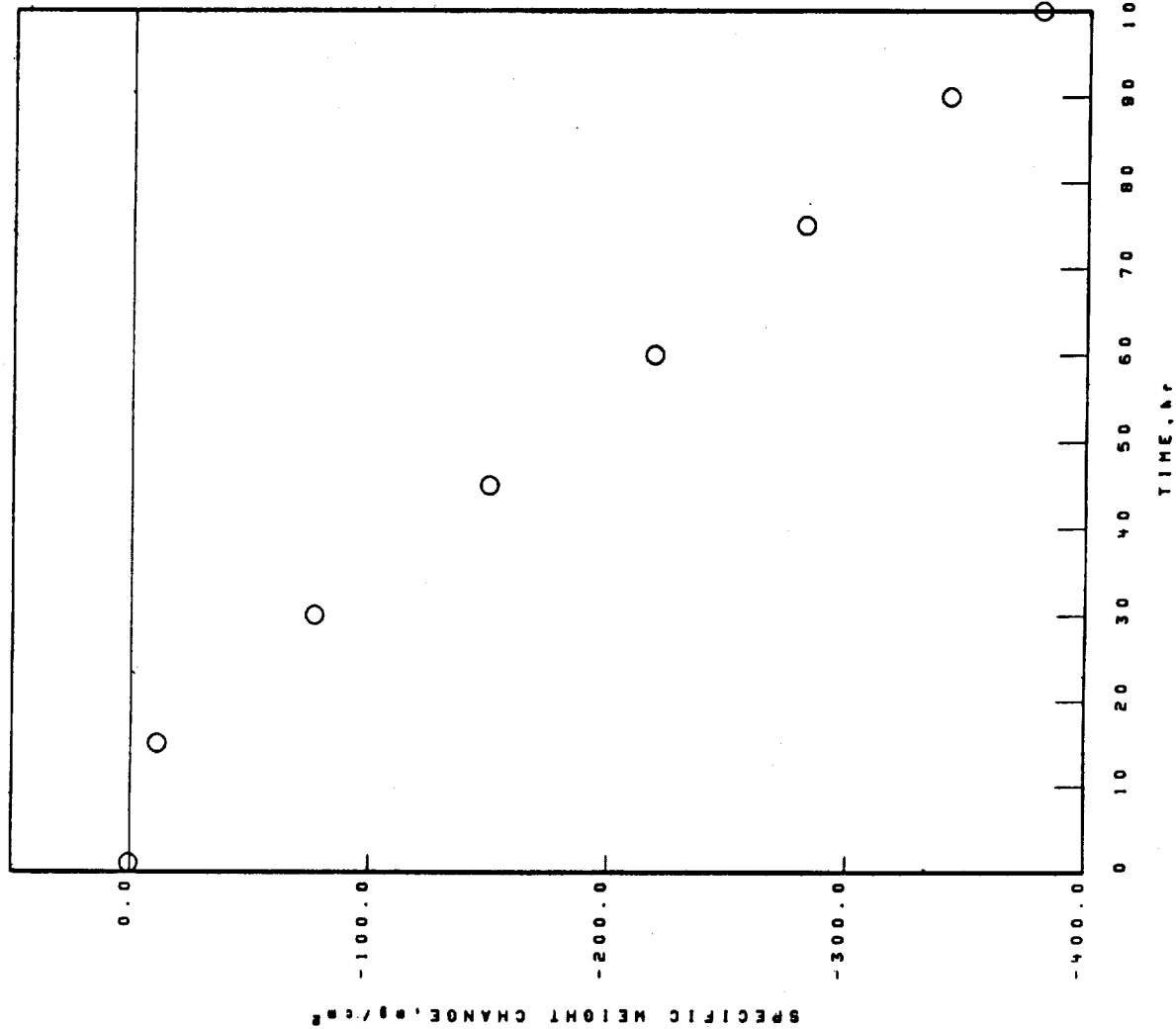
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NI0	NI0
Cr2O3	SPINEL. 2θ=8.35A-
	SPINEL. 2θ=8.05A-

FACE CENTERED CUBIC MATRIX

NI BASE  
 RENE 80  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 1.750mm THICK  
 02-04-025-108-3  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.51
15.00	-11.10
30.00	-76.73
45.00	-149.77
60.00	-218.91
75.00	-281.64
90.00	-341.71
100.00	-380.00

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-108-3  
 RENE 80 1150°C 1.00hr CYCLES 100.00hr TEST 1.750mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 NiO

SPALL  
 100 hr  
 COLLECTED SPALL  
 NiO  
 TRI(RUTILE).4(110)53.30A-  
 TRI(RUTILE).4(110)53.30A-

FACE CENTERED CUBIC MATRIX

MI BASE

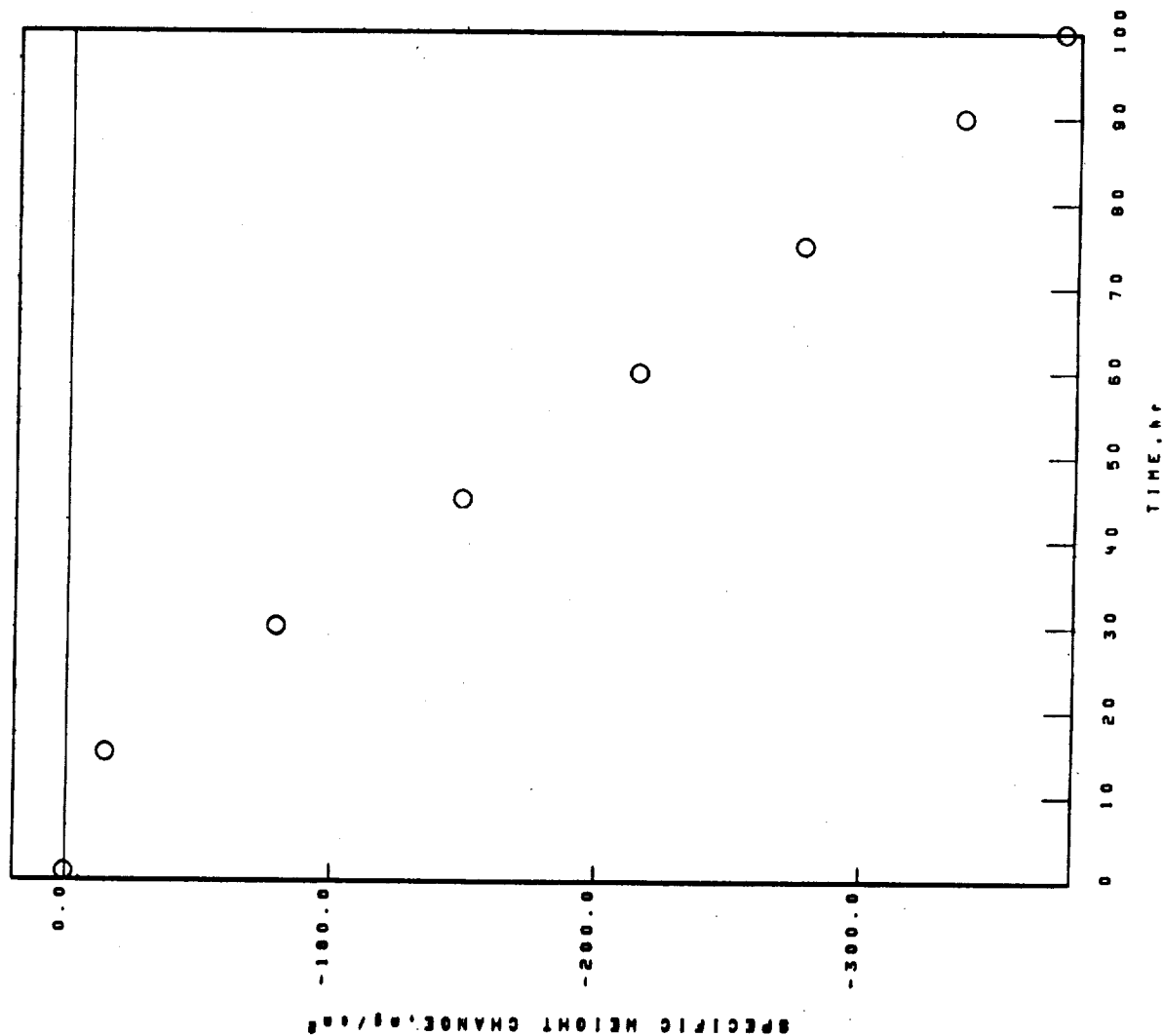
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-025-108-6

REME 88

1150°C 1.00hr CYCLES 100.00hr TEST 1.807mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



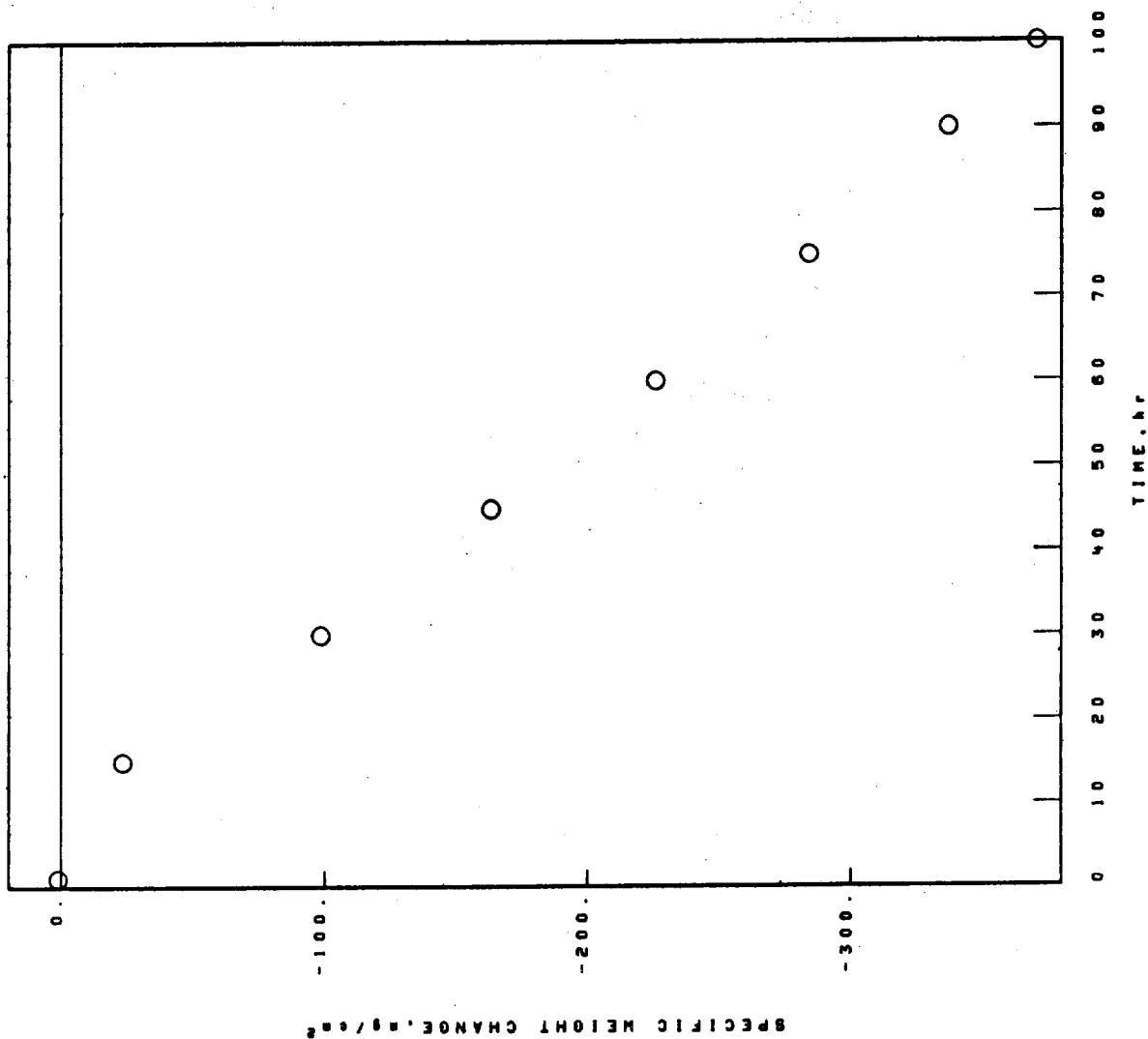
TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, mg/cm²  
0.00  
-14.61  
-78.76  
-148.63  
-214.87  
-276.50  
-336.24  
-373.88



NI BASE  
 RENE-80 (JET SHAPES)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.267mm THICK  
 02-04-055-658-2  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.19	1.19
15.00	-23.36
30.00	-98.59
45.00	-163.44
60.00	-225.95
75.00	-284.12
90.00	-337.03
100.00	-370.58

NI BASE  
 RENE-80 (JET SHAPES)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.267mm THICK STATIC AIR  
 02-04-055-658-2

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 08-8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 NiO  
 Ni(W.Mo)O, TYPE 2  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 08-8.25A.  
 Ni(W.Mo)O, TYPE 2

FACE CENTERED CUBIC MATRIX

02-04-055-659-2

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

2.252

TEST

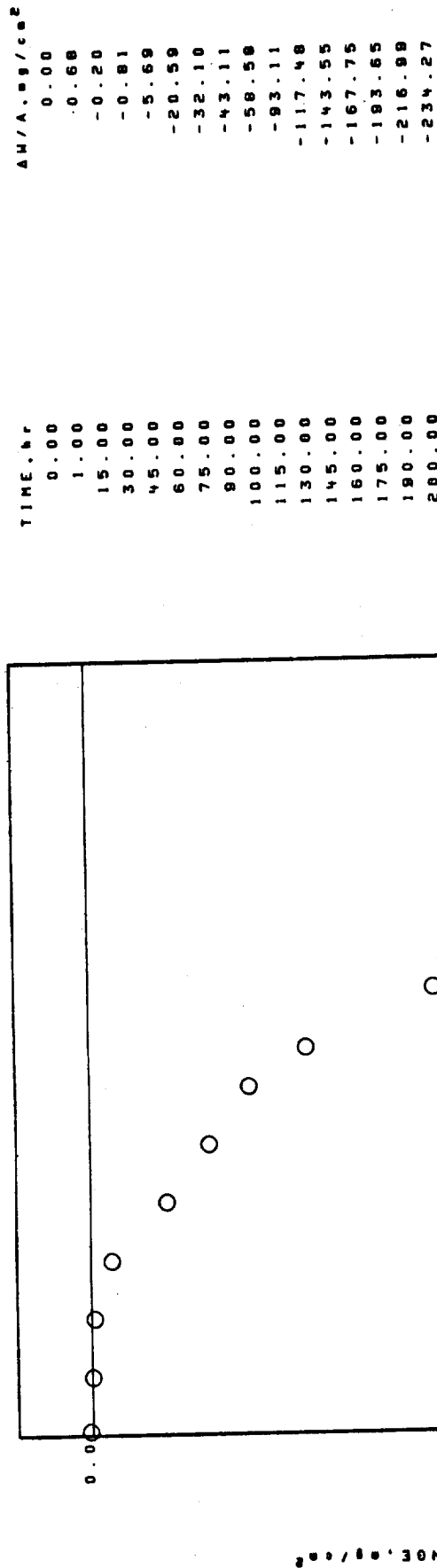
200.00hr

CYCLES

1100°C

RENE-80 (JET SHAPES)

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-055-659-2  
 RENE-80 (JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.252mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 TRI(RUTILE).4(110)13.30A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta_0=8.25A$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta_0=8.30A$ .

FACE CENTERED CUBIC MATRIX  
 200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta_0=8.30A$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta_0=8.30A$ .  
 Ni(W.M.)O<sub>4</sub> TYPE I  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>

02-04-016-108-4

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

1150°C 1.00hr CYCLES 100.00hr TEST 0.795mm THICK

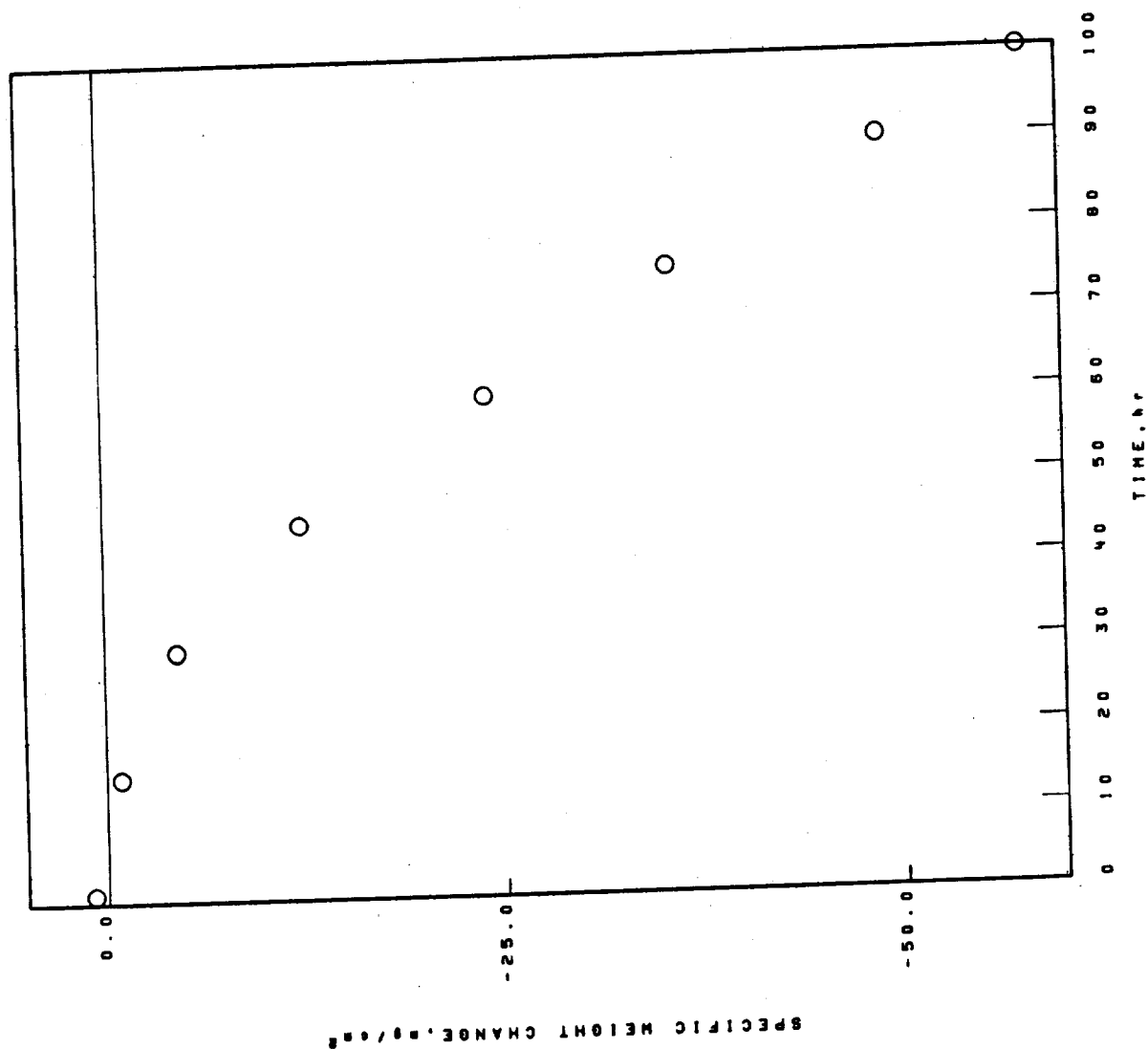
RENE 120

SPECIFIC WEIGHT CHANGE DATA

$\Delta W/A, \text{mg/cm}^2$

TIME, hr
0.00
1.00
15.00
30.00
45.00
60.00
75.00
90.00
100.00

0.00
0.84
-0.89
-4.53
-12.34
-24.03
-35.54
-48.77
-57.63



NI BASE  
 RENE 120  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 0.795mm THICK STATIC AIR  
 02-04-016-108-4

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 TRI(RUTILE), 4(110) 3.30A.

FACE CENTERED CUBIC MATRIX

SPALL  
 100 hr  
 COLLECTED SPALL  
 NiO  
 TRI(RUTILE), 4(110) 3.30A.  
 TRI(RUTILE), 4(110) 3.30A.  
 TRI(RUTILE), 4(110) 3.30A.

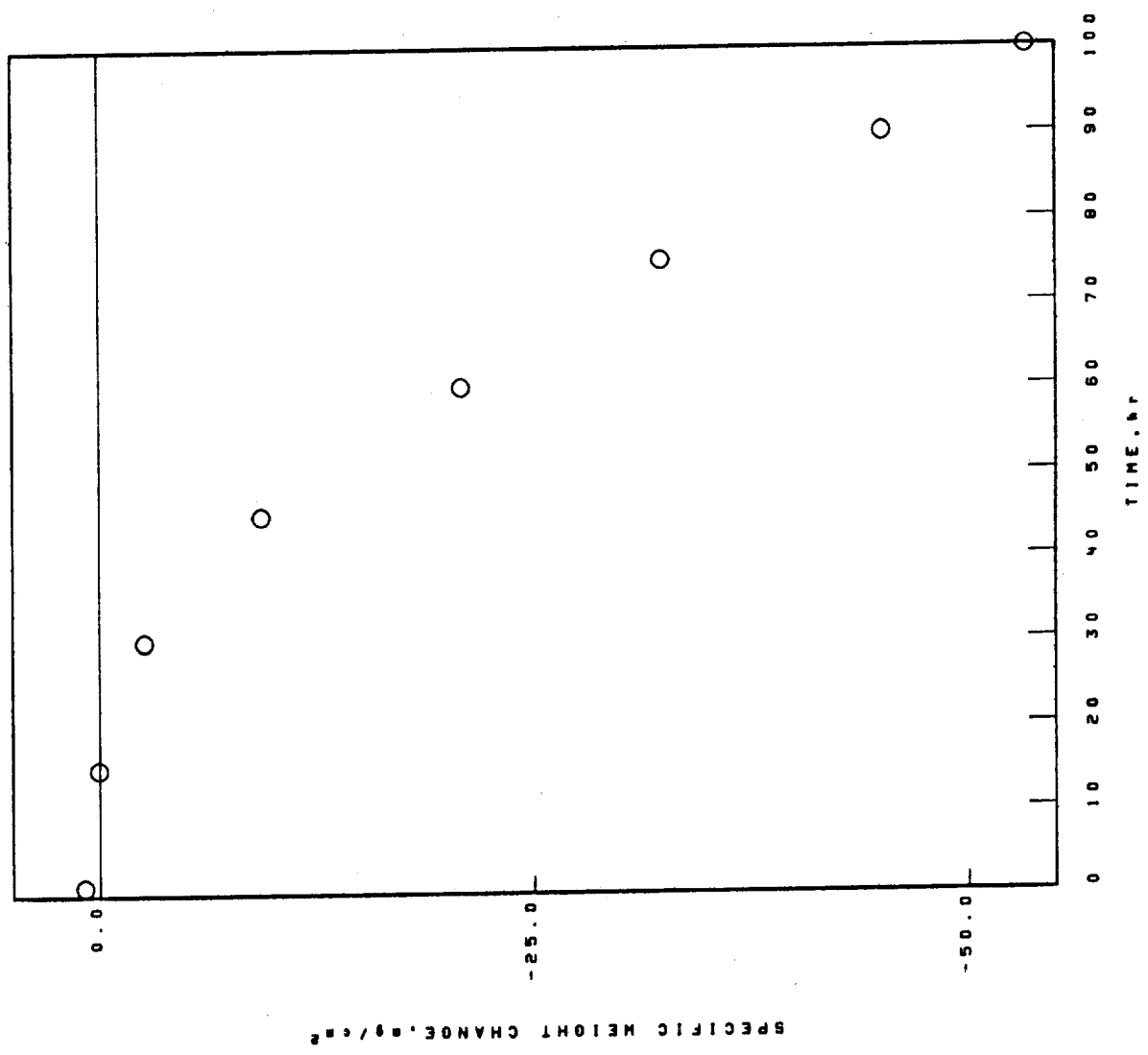
UNKNOWN LINES, 4 VALUES

2.89A.  
 3.69A.  
 2.95A.  
 1.75A.

NI BASE  
 RENE 120  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 0.733mm THICK  
 STATIC AIR  
 02-04-016-108-5

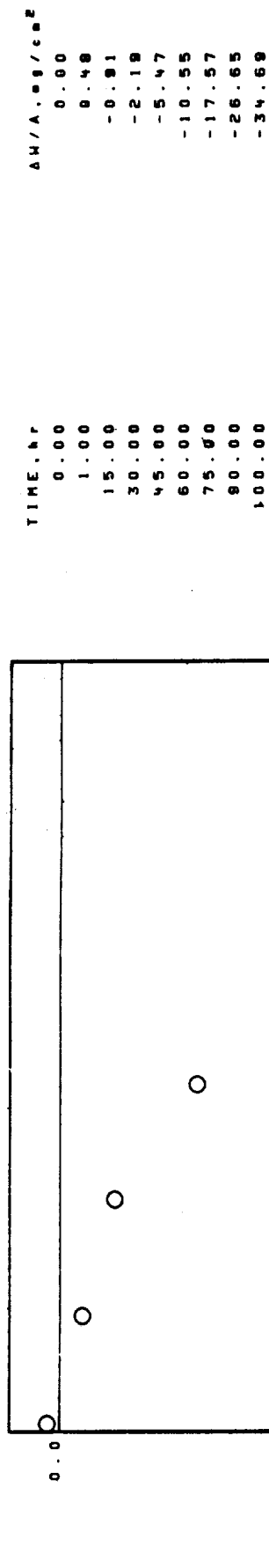
SPECIFIC HEIGHT CHANGE DATA

TIME, hr	ΔH/A, mg/cm²
0.00	0.00
1.00	0.87
15.00	0.04
30.00	-2.59
45.00	-9.34
60.00	-20.85
75.00	-32.35
90.00	-45.07
100.00	-53.30



NI BASE  
 RENE 125  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.340mm THICK STATIC AIR 02-04-017-322-4

SPECIFIC WEIGHT CHANGE DATA





COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.340mm

TEST

100.00hr

1150°C

1.00hr CYCLES

NI BASE

RENE 125

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, 90-8.10A.	NIO
TRI(RUTILE).4(110)53.30A.	NI(W.M.)O, TYPE 2
SPINEL, 90-8.25A.	SPINEL, 90-8.30A.
Al <sub>2</sub> O <sub>3</sub>	TRI(RUTILE).4(110)53.30A.
HfO <sub>2</sub>	UNKNOWN LINES, 4 VALUES
FACE CENTERED CUBIC MATRIX	3.14A.
	4.97A.
	4.38A.

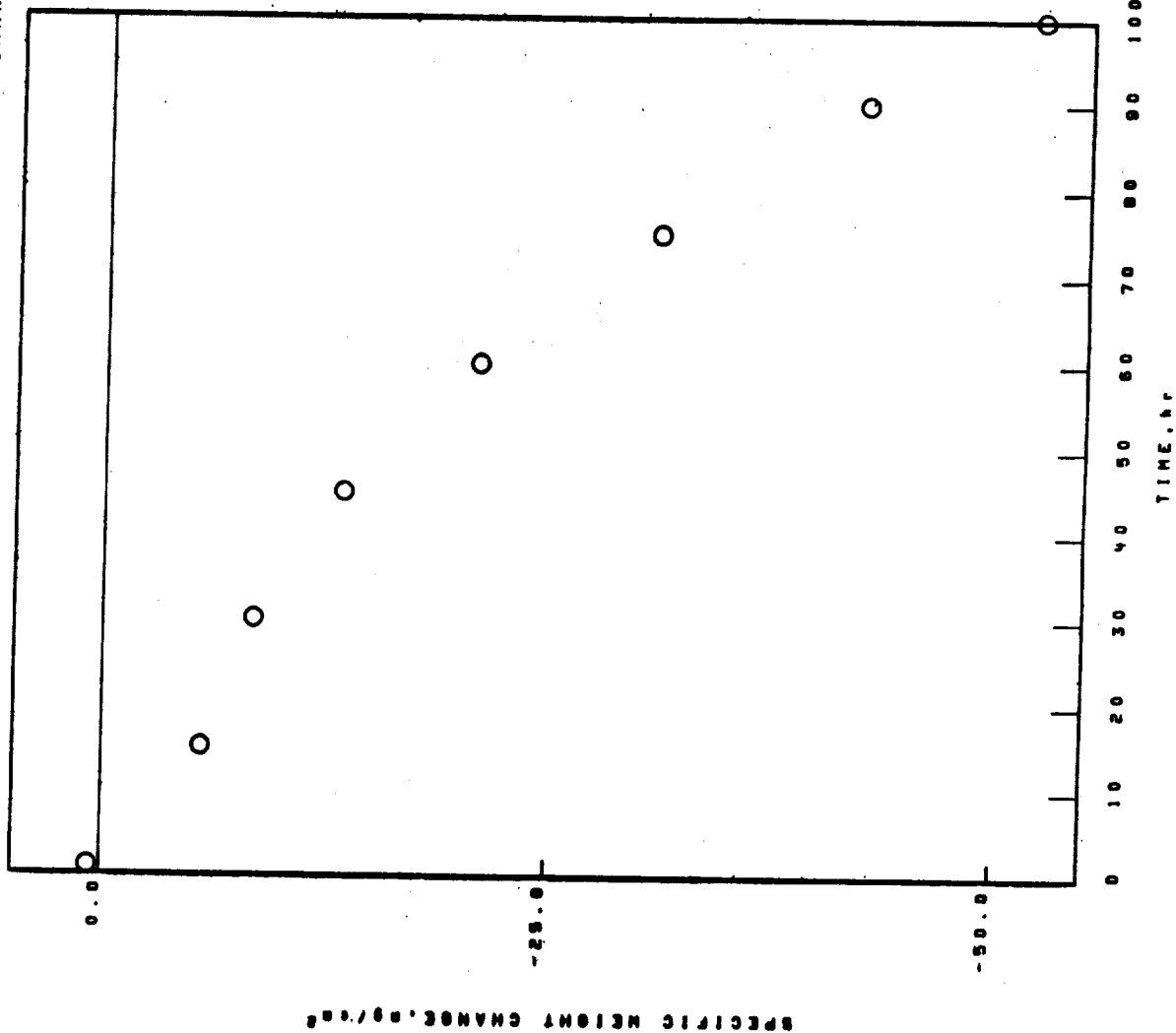
NI BASE  
RENE 129

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-017-650-4

1150°C 1.00hr CYCLES 100.00hr TEST 2.300mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.00
15.00	-5.56
30.00	-10.44
45.00	-13.37
60.00	-20.02
75.00	-30.00
90.00	-42.45
100.00	-52.21

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-017-658-4  
 RENE 125 1150°C 1.00hr CYCLES 100.00hr TEST 2.300mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL  
 1 hr  
 STANDARD SURFACE NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$  = 8.25A.  
 TRI(RUTILE).  $\theta$  (110)  $\leq$  3.30A.  
 NiO  
 TRI(RUTILE).  $\theta$  (110)  $\leq$  3.30A.  
 SPINEL.  $\theta$  = 8.10A.  
 HfO<sub>2</sub>

100 hr COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$  = 8.25A.  
 TRI(RUTILE).  $\theta$  (110)  $\leq$  3.30A.  
 Al<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>  
 NiO  
 (Ni,Co,Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

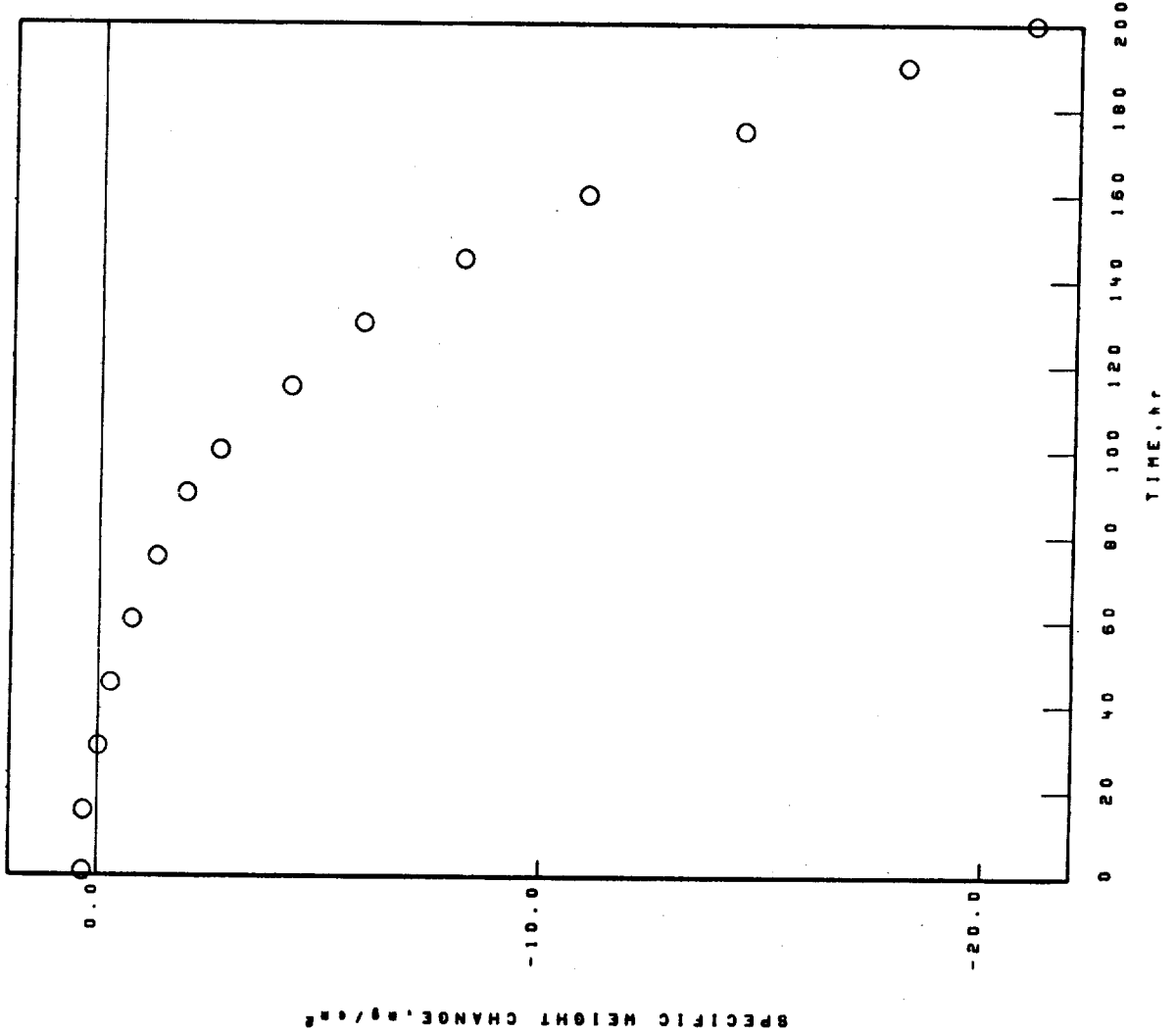
NI BASE  
RENE 125

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-017-325-4

1100°C 1.00hr CYCLES 200.00hr TEST 2.341mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
190.00  
200.00

ΔW/A, mg/cm²  
0.00  
0.33  
0.31  
-0.01  
-0.27  
-0.74  
-1.29  
-1.84  
-2.50  
-4.28  
-5.90  
-8.15  
-10.93  
-14.43  
-18.09  
-20.97

02-04-017-325-4

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS				02-04-017-325-4		
N1	BASE	TEMPERATURE	CYCLES	TEST	THICK	STATIC AIR
		1100° C	1.00NF	200.00NF	2.341	
RENE 125						

## X-RAY DIFFRACTION DATA

**SURFACE**

2004

## STANDARD SURFACE

SPINEL, 00-8.25A.

SPINEL: 8.10A.

TRI(RUTILE).  $d(110) \leq 3.30 \text{ \AA}$ .

W114 M.10. TYPE 1

Cr 203

1010

FACE CENTERED CUBIC MATRIX

**SPALL**

2004

COLLECTED SPALL

**ON**

TYPE I

TRI(RUTILE). 0(110)  $\leq$  3.30A.

SPINEL, #0-8.30A.

N1 BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

RENE-125(JET SHAPES)

1100°C

1.00hr CYCLES

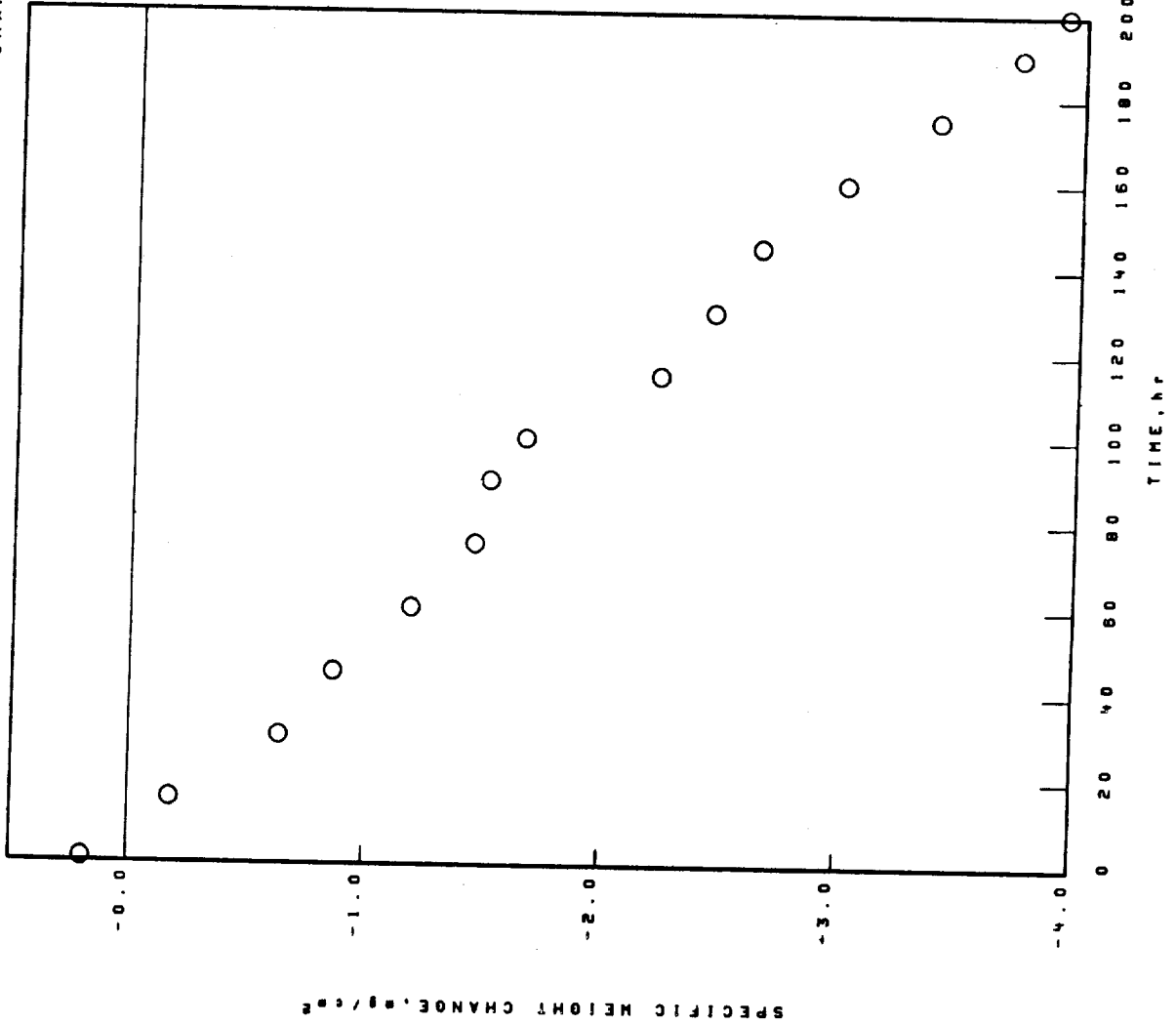
200.00hr TEST

2.316mm THICK

STATIC AIR

02-04-056-659-3

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
15.00	0.19
30.00	-0.18
45.00	-0.64
60.00	-0.86
75.00	-1.19
90.00	-1.46
100.00	-1.52
115.00	-1.66
130.00	-2.23
145.00	-2.45
160.00	-2.64
175.00	-3.00
190.00	-3.39
200.00	-3.73
200.00	-3.92

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-056-659-3  
 RENE-125 (JET SHAPES) 1100°C 1.00hr CYCLES 200.00hr TEST 2.316mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)S3.30A.

HfO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)S3.30A.

Al<sub>2</sub>O<sub>3</sub>

NiO

HfO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

HfO<sub>2</sub>

Al<sub>2</sub>O<sub>3</sub>

NiO

TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO

SPINEL. 90-8.30A.

200 hr

PROBABLE CROSS-SPALL

NiO

SPINEL. 90-8.25A.

TRI(RUTILE).4(110)S3.30A.

NI BASE

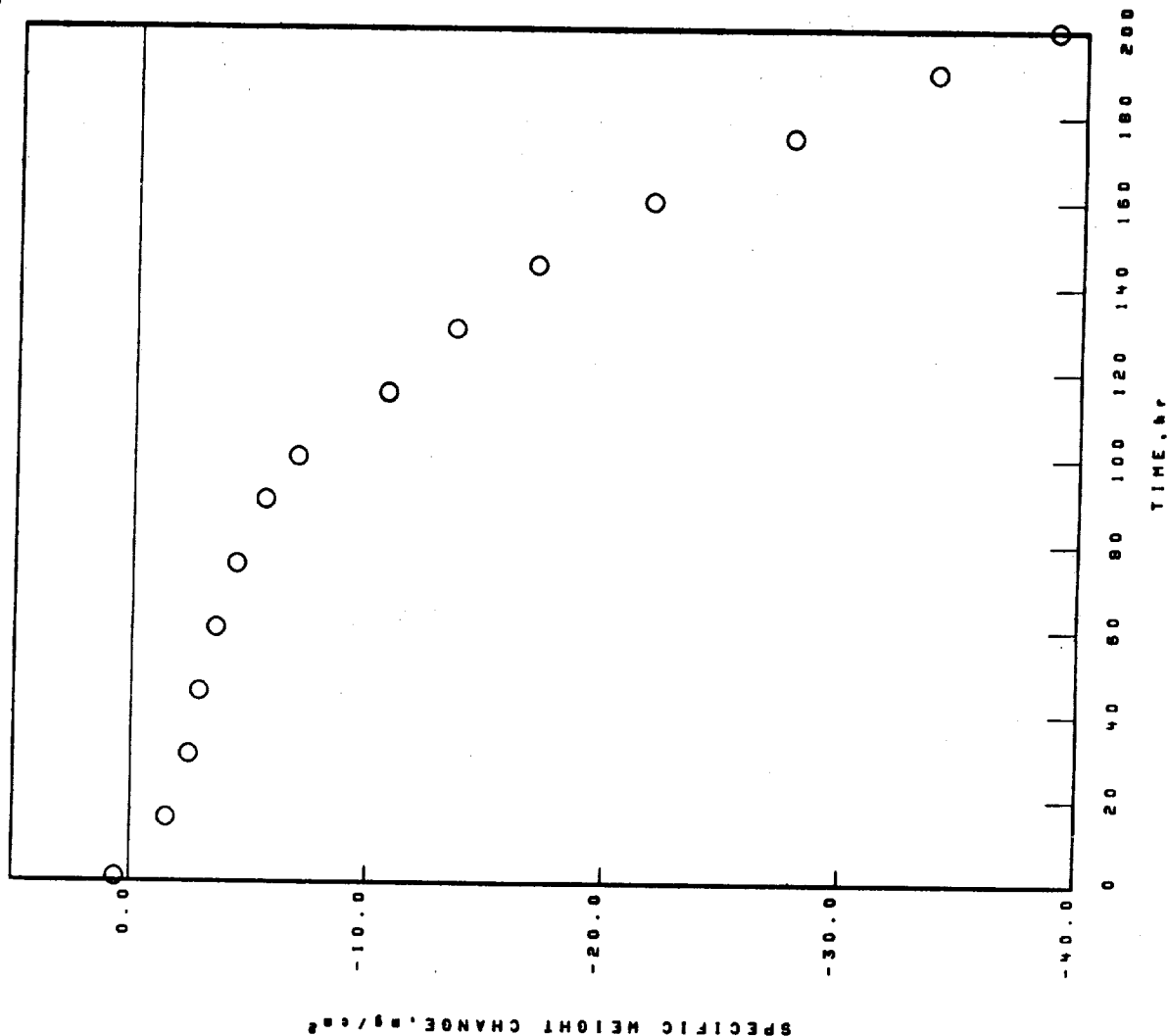
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

RENE 129

02-04-017-659-4

1100°C 1.00hr CYCLES 200.00hr TEST 2.296mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00  
115.00  
130.00  
145.00  
160.00  
175.00  
180.00  
200.00

ΔW/A, mg/cm²  
0.00  
0.62  
-1.52  
-2.45  
-2.86  
-3.52  
-4.37  
-5.54  
-6.88  
-10.66  
-13.49  
-16.91  
-21.78  
-27.67  
-33.71  
-38.76



## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

200.00hr CYCLES

1100°C

1.00hr

RENE 129

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

HfO<sub>2</sub>

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

NiO

HfO<sub>2</sub>(Ni<sub>1</sub>Co<sub>1</sub>F<sub>1</sub>)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)53.30A.

NiO

HfO<sub>2</sub>Al<sub>2</sub>O<sub>3</sub>(Ni<sub>1</sub>Co<sub>1</sub>F<sub>1</sub>)TiO<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.30A.

200 hr

## COLLECTED SPALL

NiO

SPINEL. 90-8.25A.

Ni(H<sub>2</sub>Mo)O<sub>4</sub> TYPE I

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)53.30A.

NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM SX-R-150-12-CO

1150°C

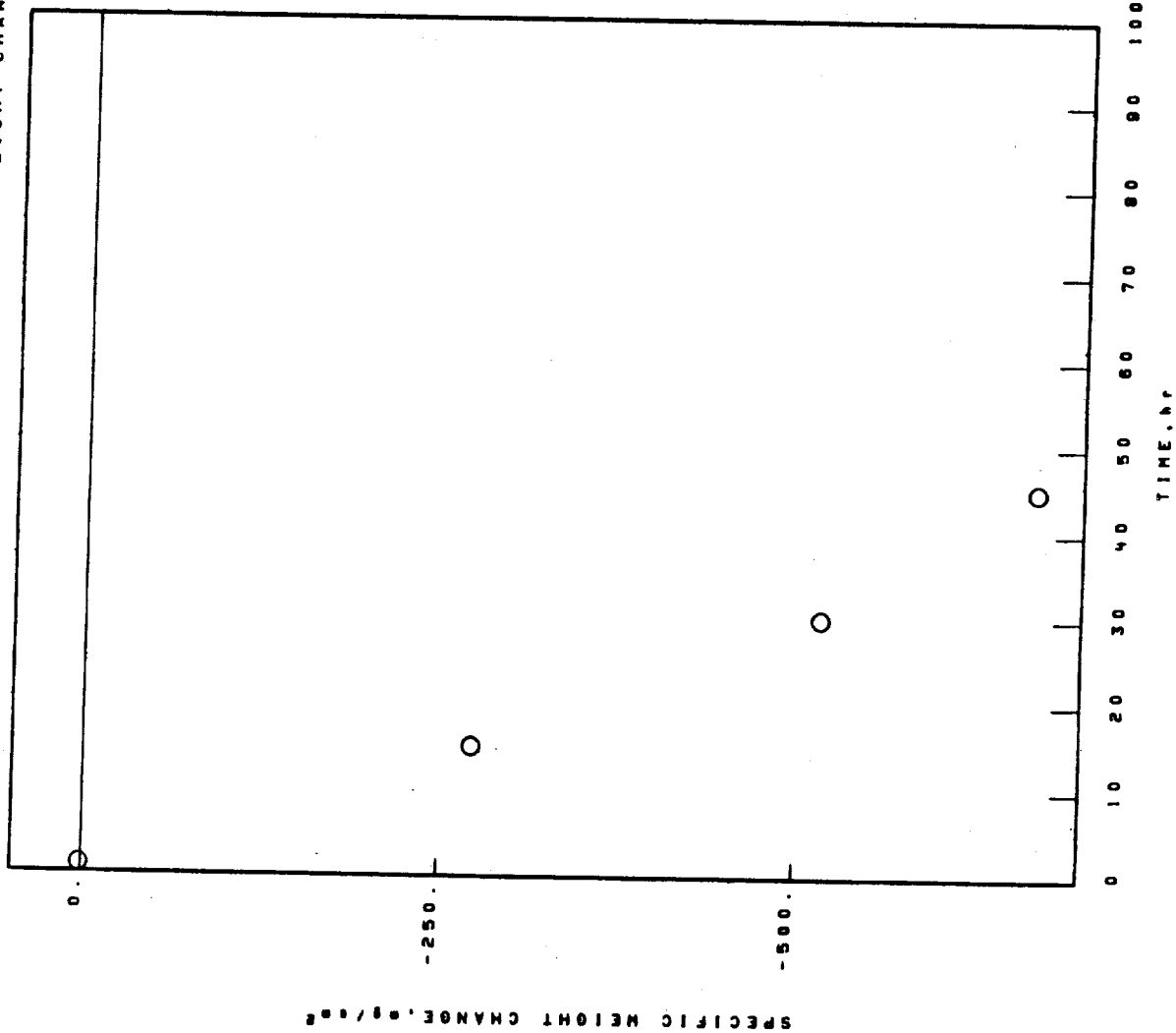
1.00hr CYCLES

45.00hr TEST 2.257mm THICK

STATIC AIR

02-09-105-613-3

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00

ΔW/A, g/cm²  
0.00  
1.46  
-272.84  
-516.58  
-667.05

NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM SX-R-150-12-CO 1150°C 1.00hr CYCLES 45.00hr TEST 2.257mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

NIO

SPINEL,  $\theta_0=8.15^\circ$ .

TRI(RUTILE),  $4(110)53.30^\circ$ .

FACE CENTERED CUBIC MATRIX

45 hr

STANDARD SURFACE

NIO

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

PROBABLE CROSS-SPALL

NIO

SPINEL,  $\theta_0=8.15^\circ$ .

TRI(RUTILE),  $4(110)53.30^\circ$ .

45 hr

COLLECTED SPALL

NIO

SPINEL,  $\theta_0=8.10^\circ$ .

NI(W.M.)O<sub>4</sub> TYPE 1

TRI(RUTILE),  $4(110)53.30^\circ$ .

NI BASE  
EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM SX-R-150-12.CO

1100°C

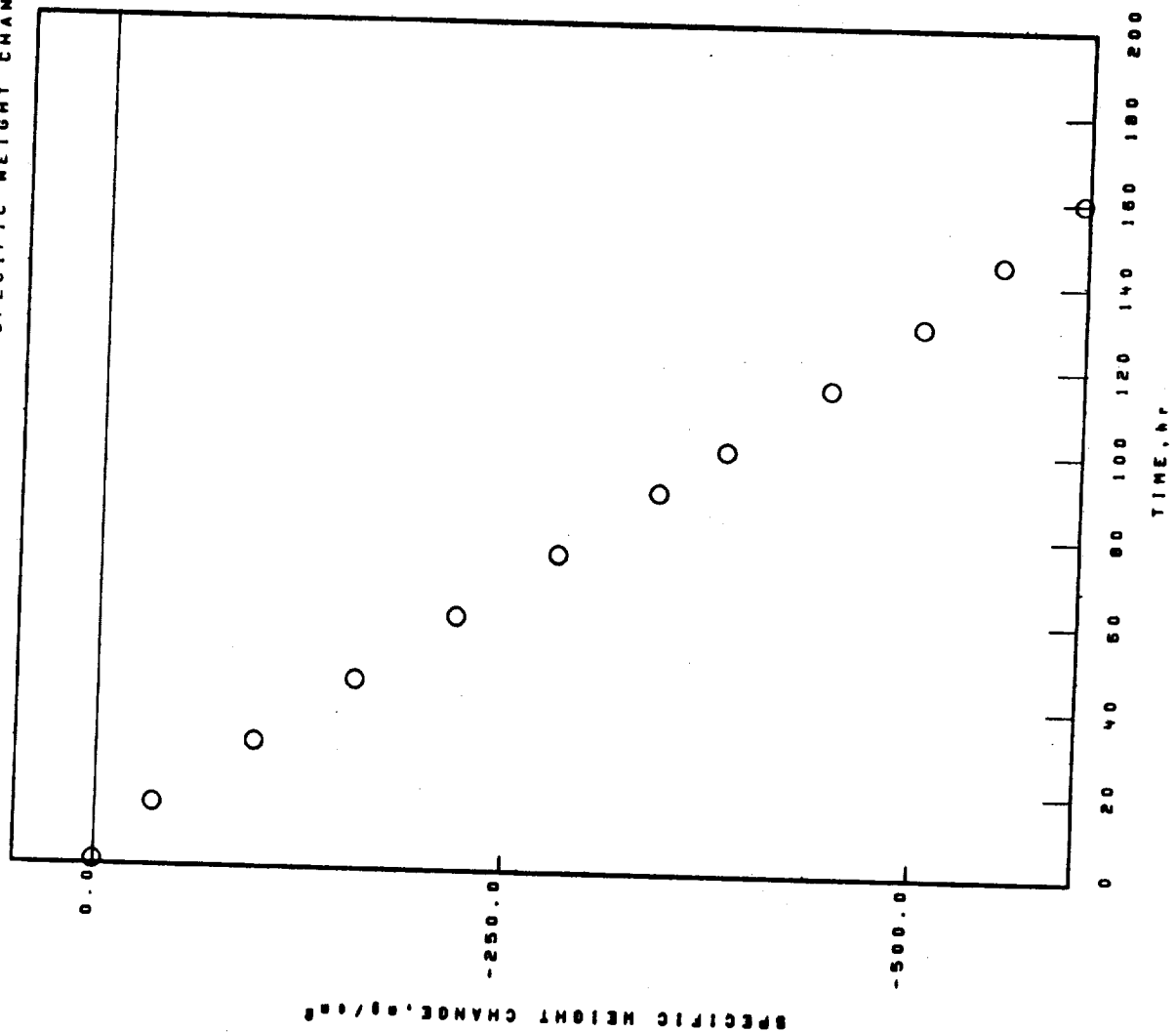
1.00hr CYCLES

160.00hr TEST 2.294mm THICK

STATIC AIR

02-09-185-614-3

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.61
15.00	-35.00
30.00	-96.68
45.00	-157.36
60.00	-218.78
75.00	-280.04
90.00	-340.89
100.00	-381.61
115.00	-444.66
130.00	-500.02
145.00	-547.73
160.00	-596.41

## EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE 1100°C 1.00hr CYCLES 160.00hr TEST 2.294mm THICK STATIC AIR

COSAM SX-R-150-12-CO

X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

NiO

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8-10A.

TRI(RUTILE).4(110)&gt;&gt;3.30A.

## FACE CENTERED CUBIC MATRIX

100 hr

## STANDARD SURFACE

NiO

Ni(W.M.10), TYPE 1

SPINEL. 00-8-10A.

TRI(RUTILE).4(110)&gt;&gt;3.30A.

## FACE CENTERED CUBIC MATRIX

200 hr

## STANDARD SURFACE

NiO

SPINEL. 00-8-10A.

Ni(W.M.10), TYPE 1

TRI(RUTILE).4(110)&gt;&gt;3.30A.

## FACE CENTERED CUBIC MATRIX

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

## COLLECTED SPALL

NiO

Ni(W.M.10), TYPE 1

TRI(RUTILE).4(110)&gt;&gt;3.30A.

SPINEL. 00-8-10A.

200 hr

## COLLECTED SPALL

NiO

SPINEL. 00-8-10A.

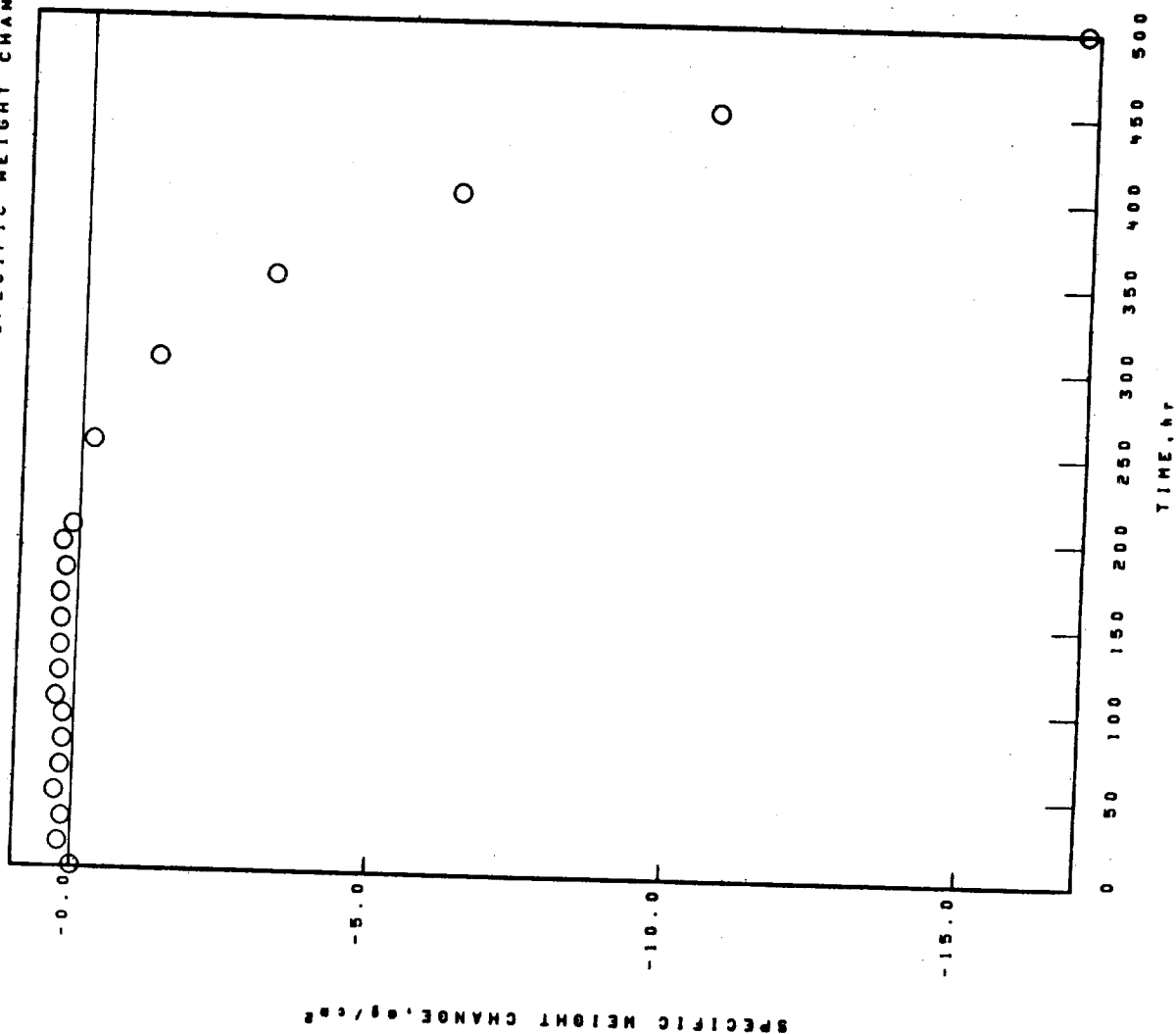
Ni(W.M.10), TYPE 1

TRI(RUTILE).4(110)&gt;&gt;3.30A.

NI BASE  
COSAM SX-R-150-12.CO  
EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS  
1000°C 1.00hr CYCLES 500.00hr TEST 2.284mm THICK STATIC AIR

02-09-185-615-3

SPECIFIC WEIGHT CHANGE DATA



## EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE 1000°C 1.00hr CYCLES 500.00hr TEST 2.284mm THICK STATIC AIR

COSAH SX-R-150-12.CO

## X-RAY DIFFRACTION DATA

SURFACE  
1 hr  
STANDARD SURFACE  
SPINEL.  $\theta_0=8.10A$ .  
Al<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)>3.30A.  
FACE CENTERED CUBIC MATRIX

100 hr  
STANDARD SURFACE  
Al<sub>2</sub>O<sub>3</sub>  
SPINEL.  $\theta_0=8.10A$ .  
TRI(RUTILE).4(110)>3.30A.  
FACE CENTERED CUBIC MATRIX

100 hr  
PROBABLE CROSS-SPALL  
NiO  
SPINEL.  $\theta_0=8.25A$ .

200 hr  
STANDARD SURFACE  
Al<sub>2</sub>O<sub>3</sub>  
SPINEL.  $\theta_0=8.10A$ .  
TRI(RUTILE).4(110)>3.30A.  
FACE CENTERED CUBIC MATRIX

200 hr  
COLLECTED SPALL  
NiO

500 hr  
STANDARD SURFACE  
SPINEL.  $\theta_0=8.10A$ .  
NiO  
TRI(RUTILE).4(110)>3.30A.  
SPINEL.  $\theta_0=8.25A$ .  
Al<sub>2</sub>O<sub>3</sub>  
FACE CENTERED CUBIC MATRIX

500 hr  
COLLECTED SPALL  
NiO  
SPINEL.  $\theta_0=8.10A$ .  
TRI(RUTILE).4(110)>3.30A.

N1 BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM SX-R-150-12.CO

1000°C

1.00hr CYCLES

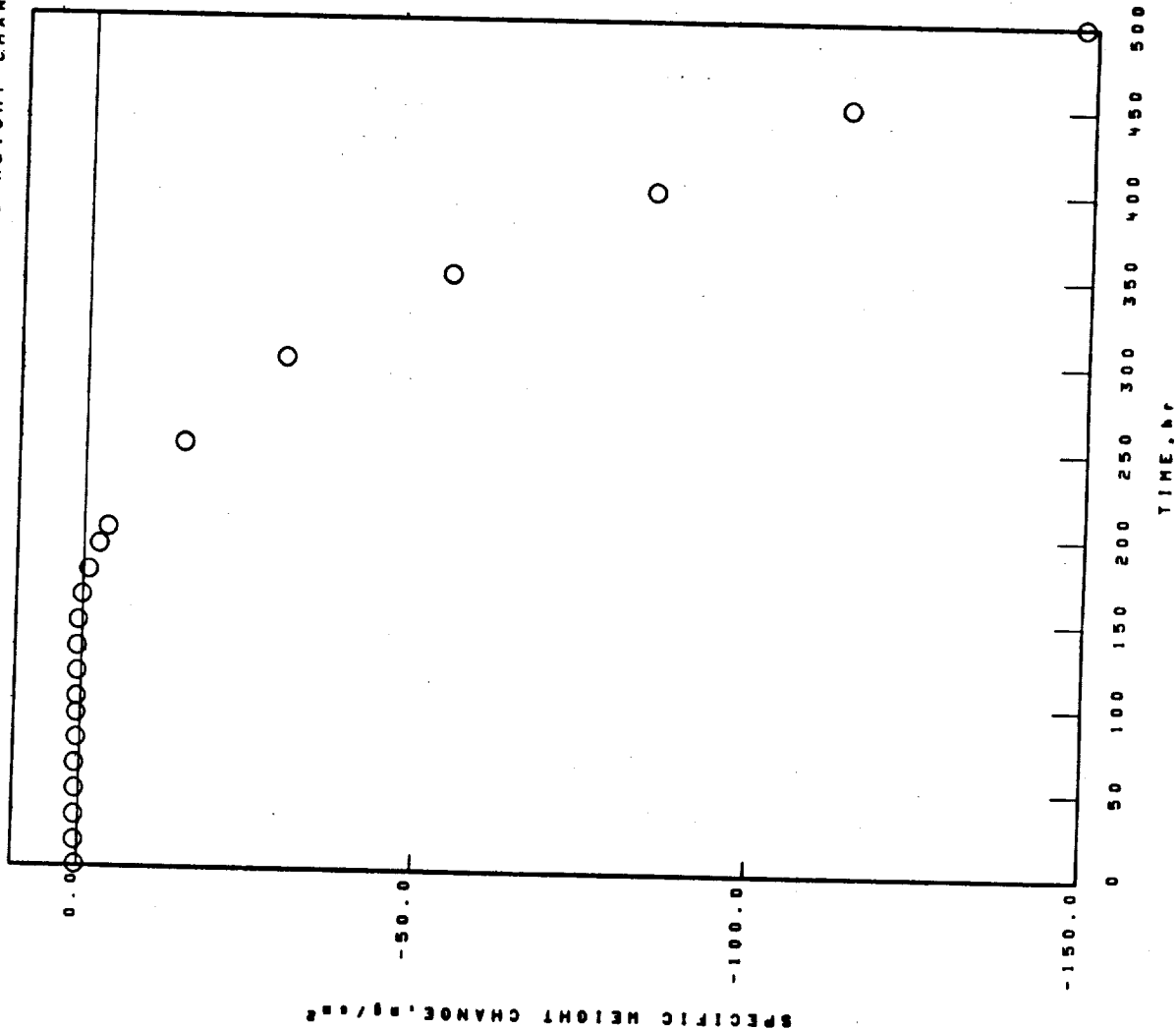
500.00hr TEST

2.296mm THICK

STATIC AIR

02-13-185-678-6

SPECIFIC WEIGHT CHANGE DATA





NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

500.00hr TEST

1.00hr CYCLES

1000°C

COSAM SX-R-150-12.CO

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.15A.

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $\theta_0$ -8.25A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.28A.

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

Ni(W.M.)O<sub>4</sub> TYPE I

SPINEL.  $\theta_0$ -8.10A.

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

NiO

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

Ni(W.M.)O<sub>4</sub> TYPE I

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

COLLECTED SPALL

NiO

Ni(W.M.)O<sub>4</sub> TYPE I

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

SPINEL.  $\theta_0$ -8.10A.

500 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.10A.

TRI(RUTILE).  $\delta(110)$   $\delta$ 3.30A.

Ni(W.M.)O<sub>4</sub> TYPE I

NI BASE

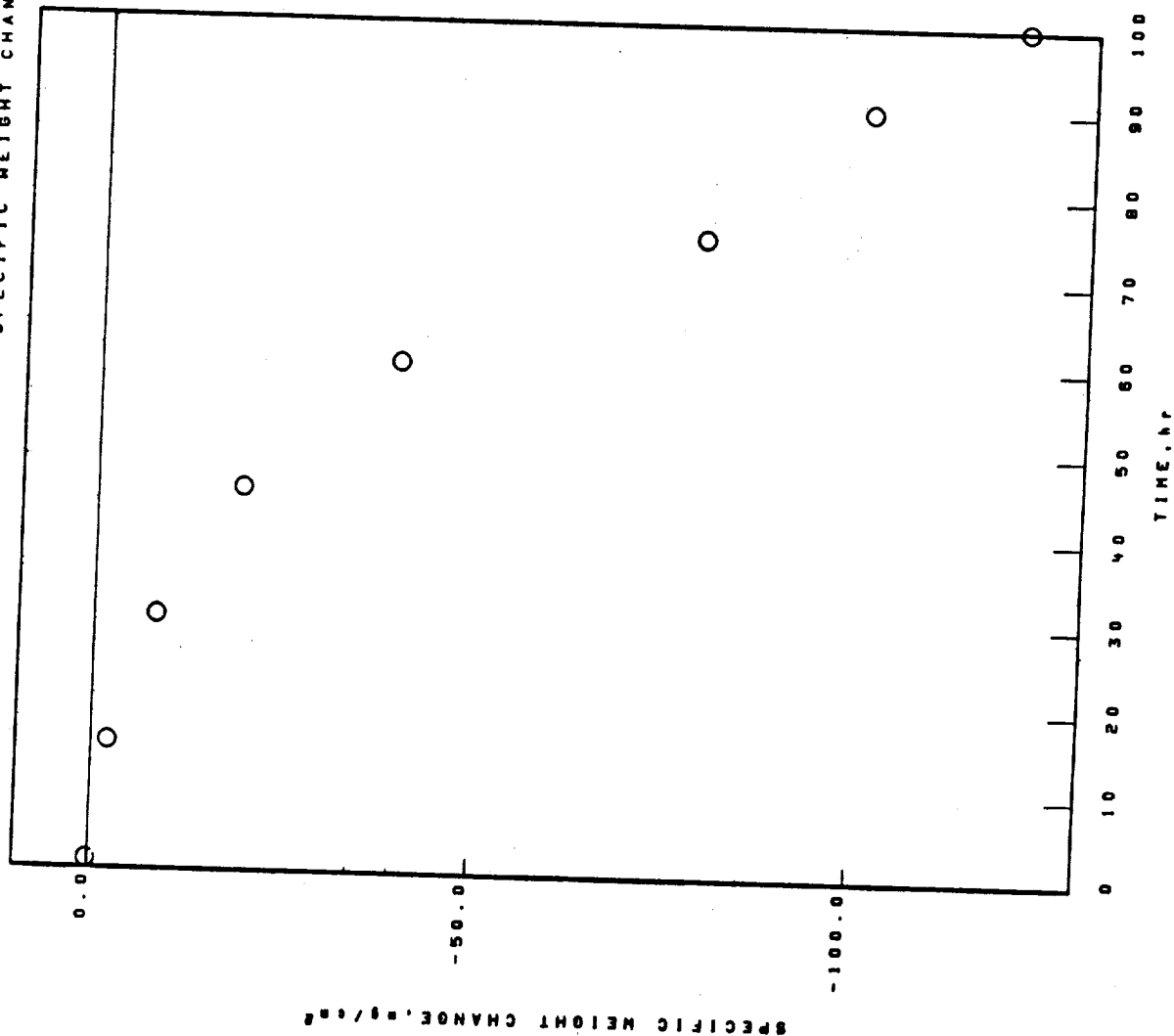
COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

TAZ-BA

02-04-019-107-3

1150°C 1.00hr CYCLES 100.00hr TEST 2.433mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

ΔW/A, g/cm²  
0.00  
0.23  
-2.17  
-6.10  
-10.04  
-38.37  
-78.07  
-100.63  
-120.87

02-04-019-107-6

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

100.00hr TEST 2.415mm THICK

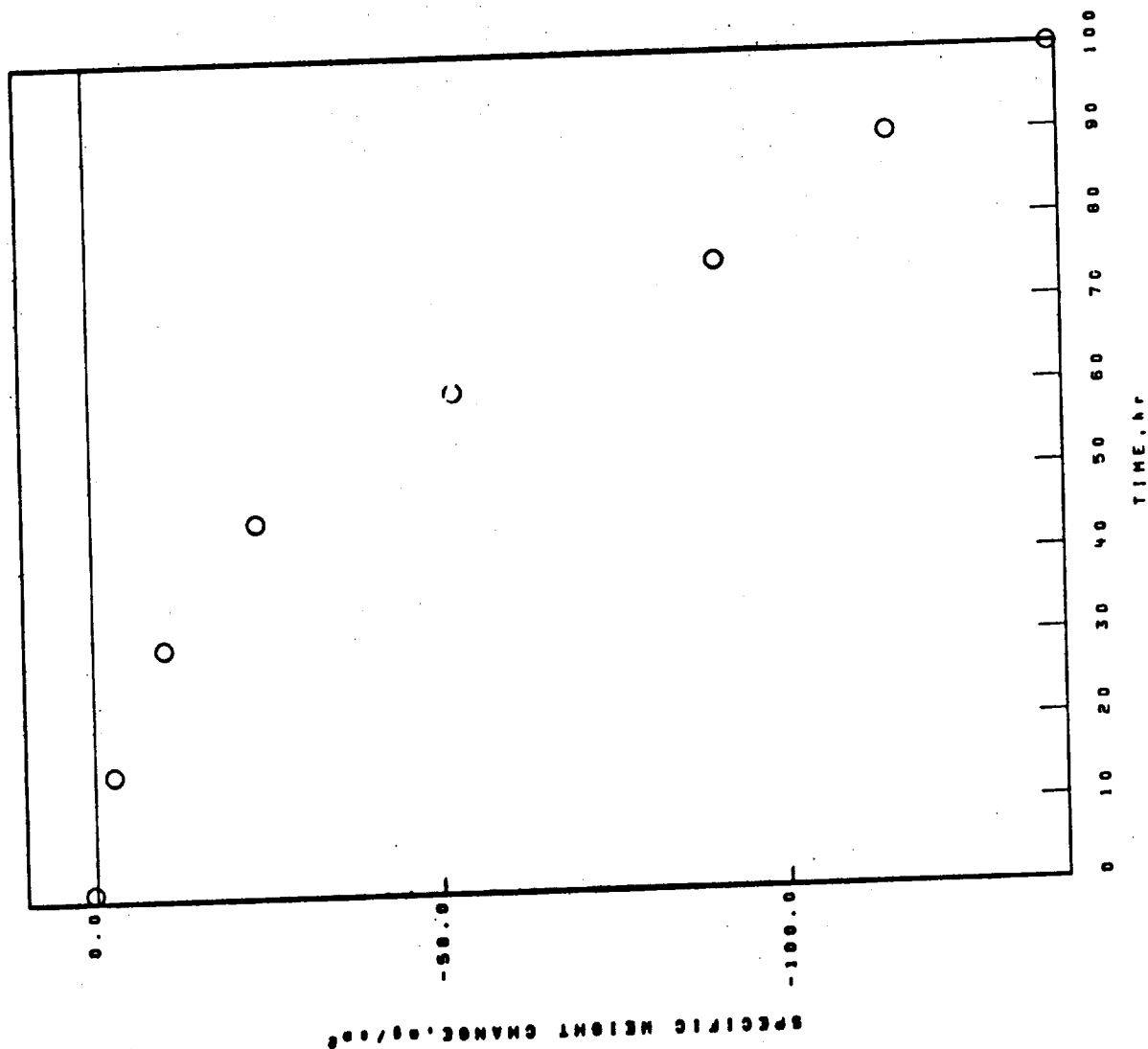
TAZ-8A

1150°C

1.00hr CYCLES

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.36
15.00	-2.73
30.00	-10.30
45.00	-23.84
60.00	-52.53
75.00	-88.48
90.00	-115.44
100.00	-130.95



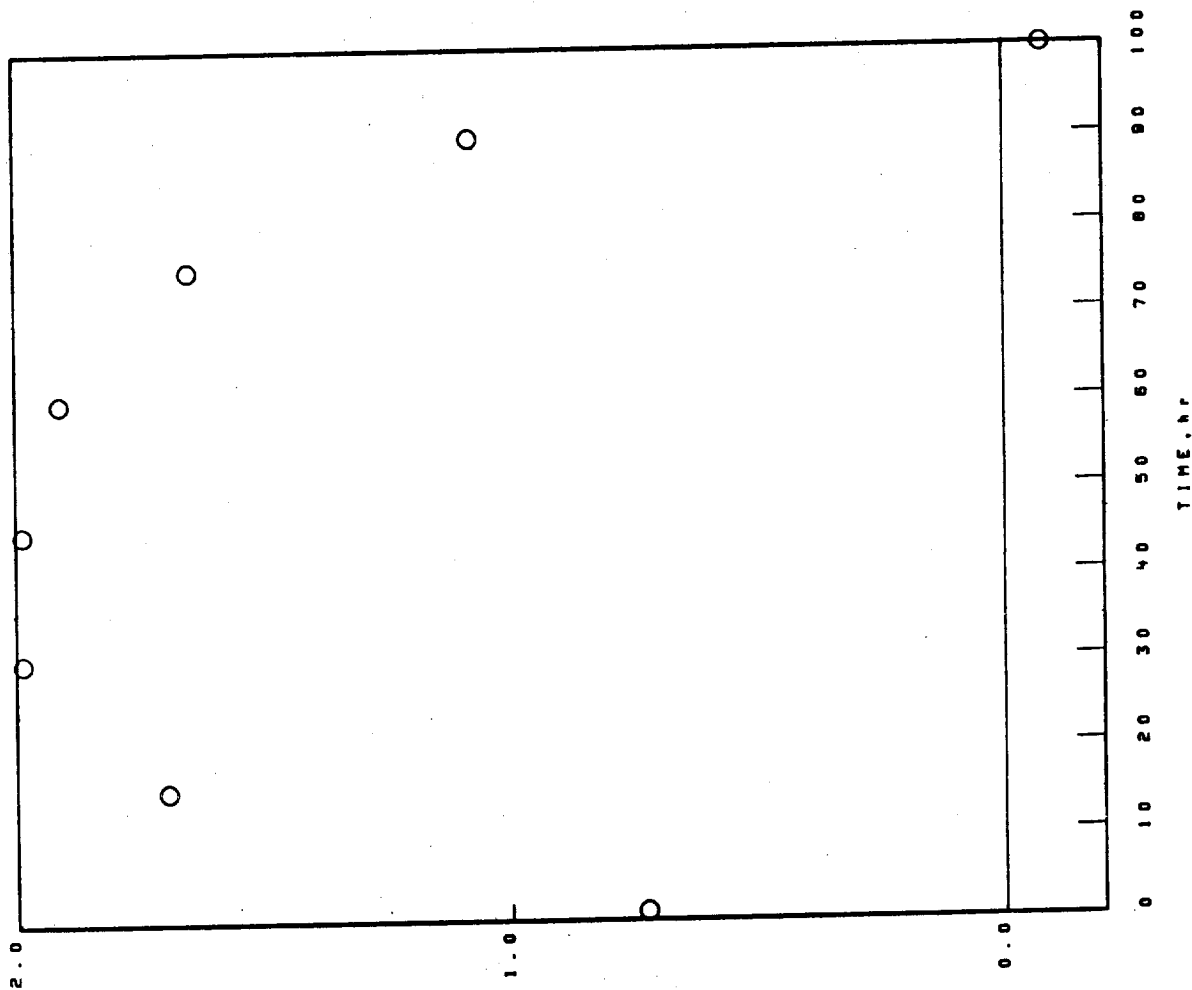
NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.415mm THICK STATIC AIR  
 02-04-019-107-6

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
TRI(RUTILE).4(110)S3.30A.	TRI(RUTILE).4(110)S3.30A.
SPINEL. 8-8.25A.	TRI(RUTILE).4(110)S3.30A.
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES. 4 VALUES
	2.88A.

NI BASE  
 TAZ-BA  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.315mm THICK STATIC AIR  
 02-04-019-321-3

SPECIFIC WEIGHT CHANGE DATA



SPECIFIC WEIGHT CHANGE, g/cm³

NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.315mm THICK  
 02-04-019-321-3  
 STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. 80-8.10A.	NIO
TRI(RUTILE). 4(110)>3.30A.	TRI(RUTILE). 4(110)>3.30A.
NIO	SPINEL. 80-8.10A.
Al <sub>2</sub> O <sub>3</sub>	SPINEL. 80-8.25A.
ZrO <sub>2</sub>	NI(W.M.)O, TYPE 1
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES. 4 VALUES
	2.96A.

02-04-019-414-6

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

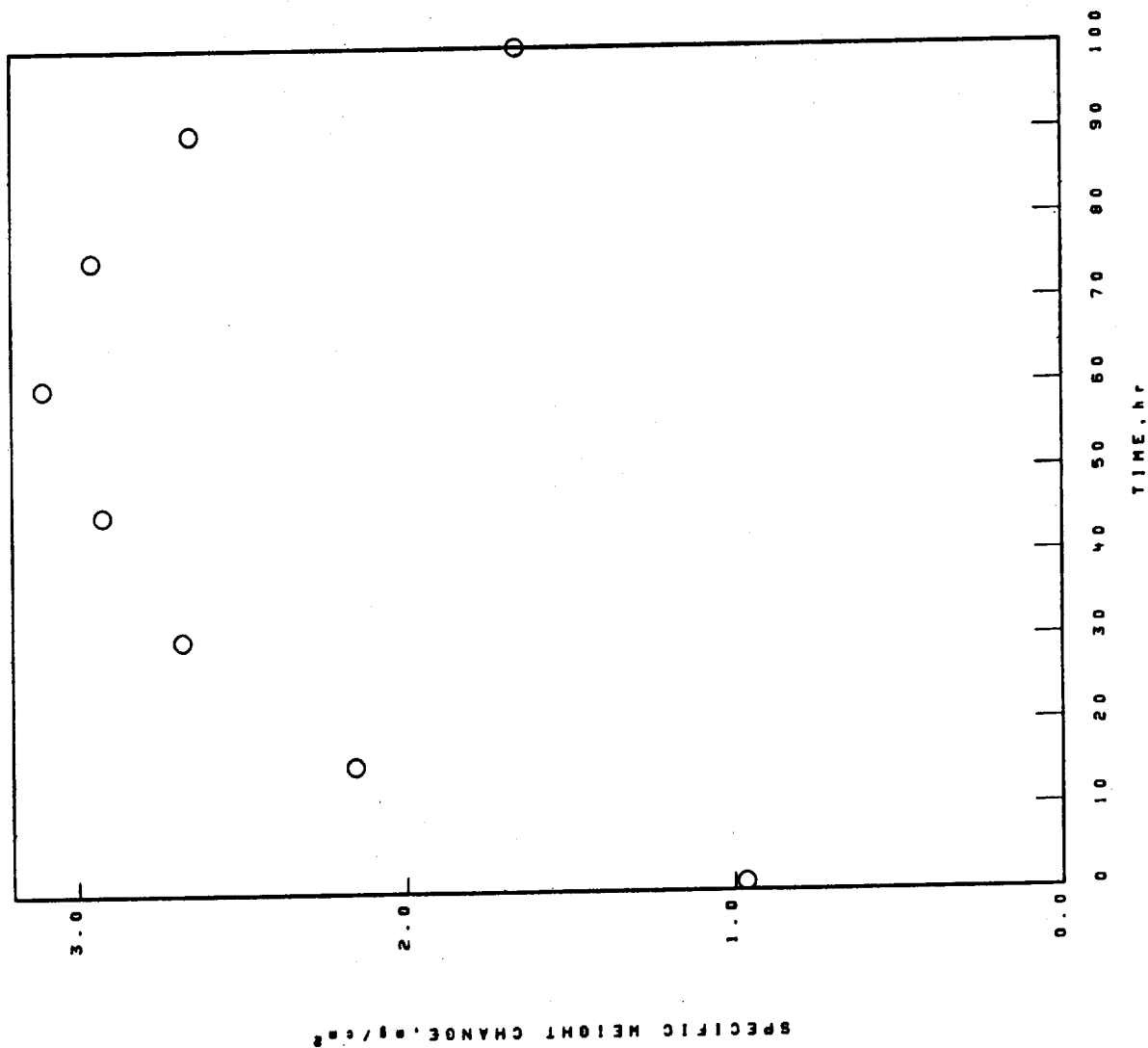
THICK 2.300mm TEST 100.00hr

1.00hr CYCLES 1150°C

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, g/cm^2$
0.00	0.00
1.00	0.96
15.00	2.15
30.00	2.68
45.00	2.92
60.00	3.10
75.00	2.95
90.00	2.65
100.00	1.66



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.300mm THICK  
 02-04-019-414-8  
 STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL,  $\theta = 8.15^\circ$

TRI(RUTILE),  $4(110) \gg 3.30^\circ$

NiO

ZrO<sub>2</sub>

SPALL

100 hr

COLLECTED SPALL

NiO

SPINEL,  $\theta = 8.30^\circ$

TRI(RUTILE),  $4(110) \gg 3.30^\circ$

Ni(W.M.)O, TYPE I

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES,  $d$  VALUES

2.67Å



STATIC AIR

THICK

TEST

100.00hr

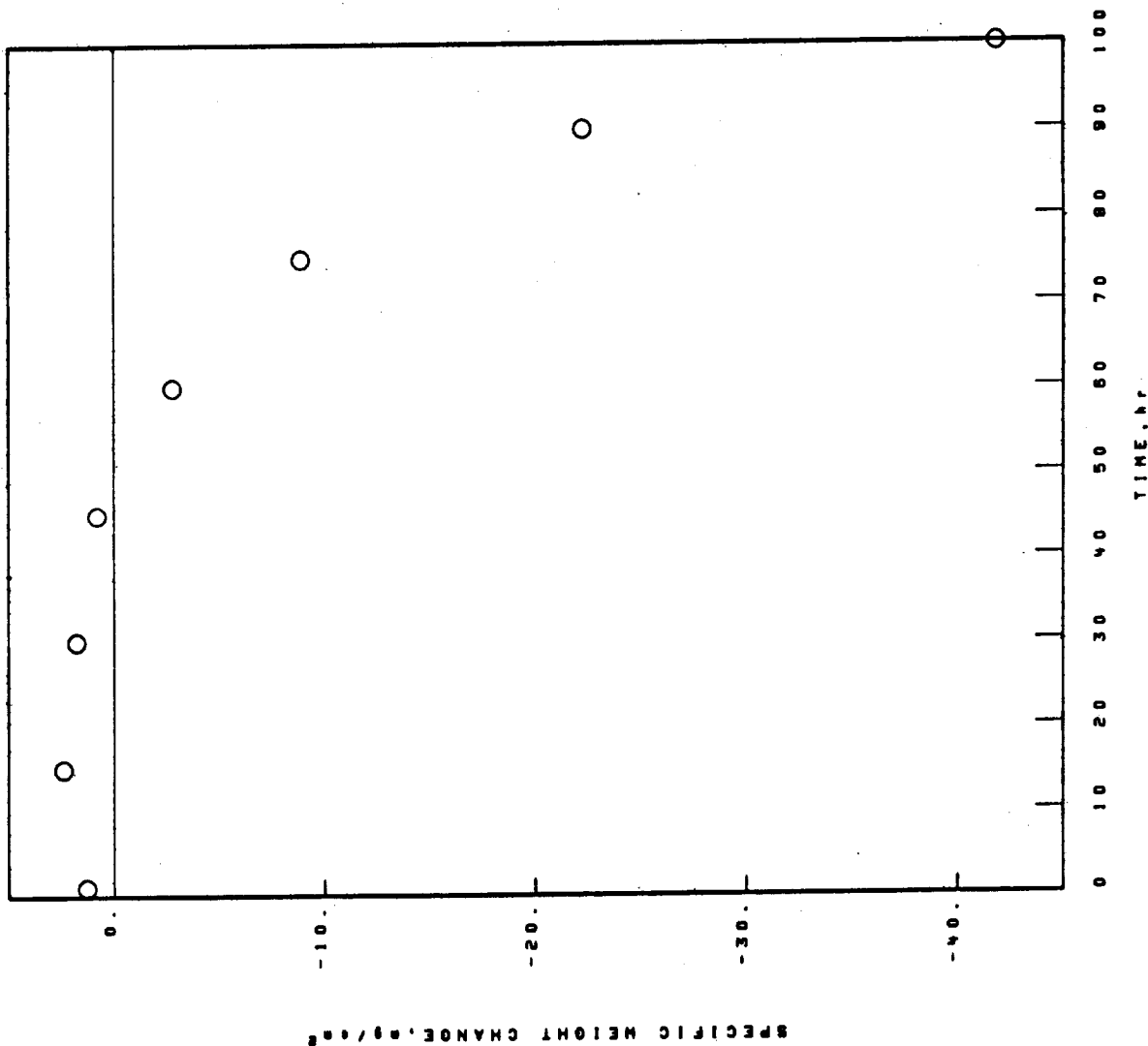
1150°C

1.00hr

CYCLES

TAZ-BA

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-425-3  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.322mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
SPINEL, $a_0=8.30\text{\AA}$ .	TRI(RUTILE), $d(110)>3.30\text{\AA}$ .
TRI(RUTILE), $d(110)>3.30\text{\AA}$ .	Ni(W.M.)O, TYPE 1
Ni(W.M.)O, TYPE 1	SPINEL, $a_0=8.25\text{\AA}$ .

FACE CENTERED CUBIC MATRIX

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

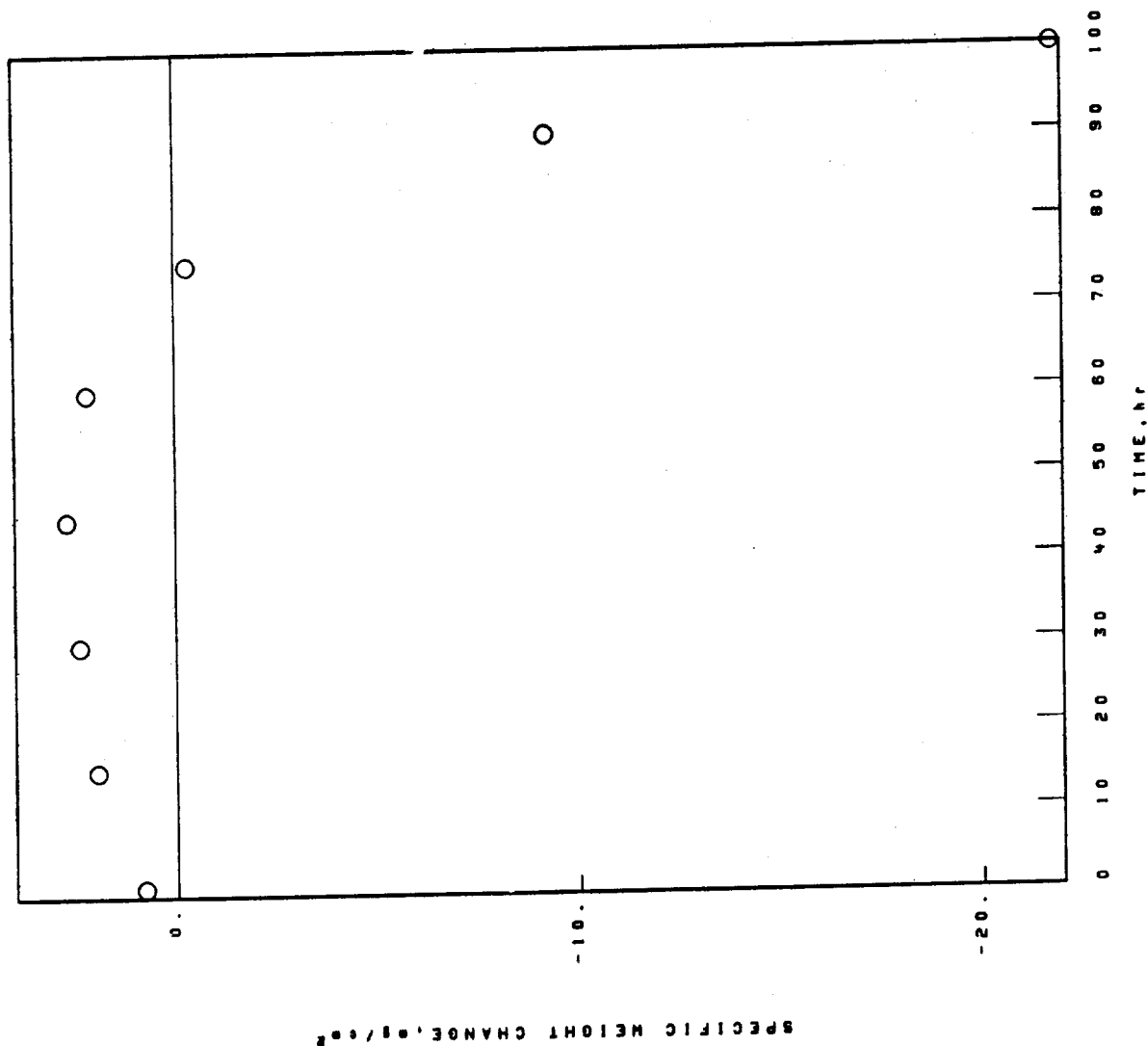
TEST 2.29mm

100.00hr CYCLES 1.00hr

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	0.80
15.00	1.97
30.00	2.40
45.00	2.71
60.00	2.20
75.00	-0.30
90.00	-9.24
100.00	-21.76



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.294mm THICK  
 STATIC AIR  
 02-04-019-425-6

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NIO

TRI(RUTILE).4(110)>3.30A.

SPINEL. 8.25A.

NI(W.M.)O<sub>4</sub> TYPE 1

SPALL

100 hr

COLLECTED SPALL

NIO

TRI(RUTILE).4(110)>3.30A.

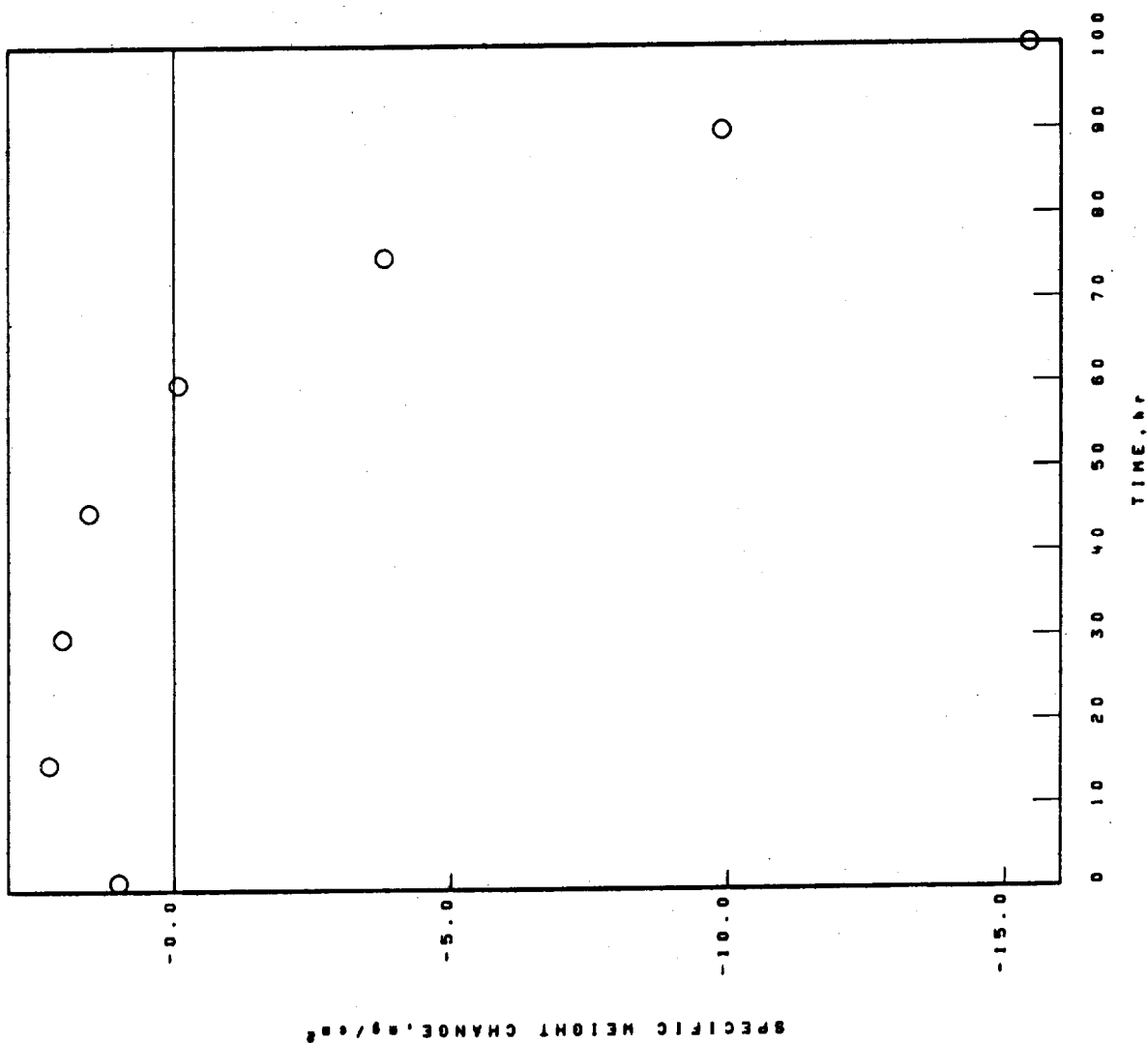
NI(W.M.)O<sub>4</sub> TYPE 1

SPINEL. 8.25A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.304mm THICK  
 STATIC AIR  
 02-04-019-426-3

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-426-3  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta$ -8.10A.	NIO
TRI(RUTILE). $\theta$ (110)>3.30A.	TRI(RUTILE). $\theta$ (110)>3.30A.
NIO	SPINEL. $\theta$ -8.10A.
	NI(W.M.)O, TYPE I

FACE CENTERED CUBIC MATRIX

02-04-019-426-6

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

100.00hr

1150°C

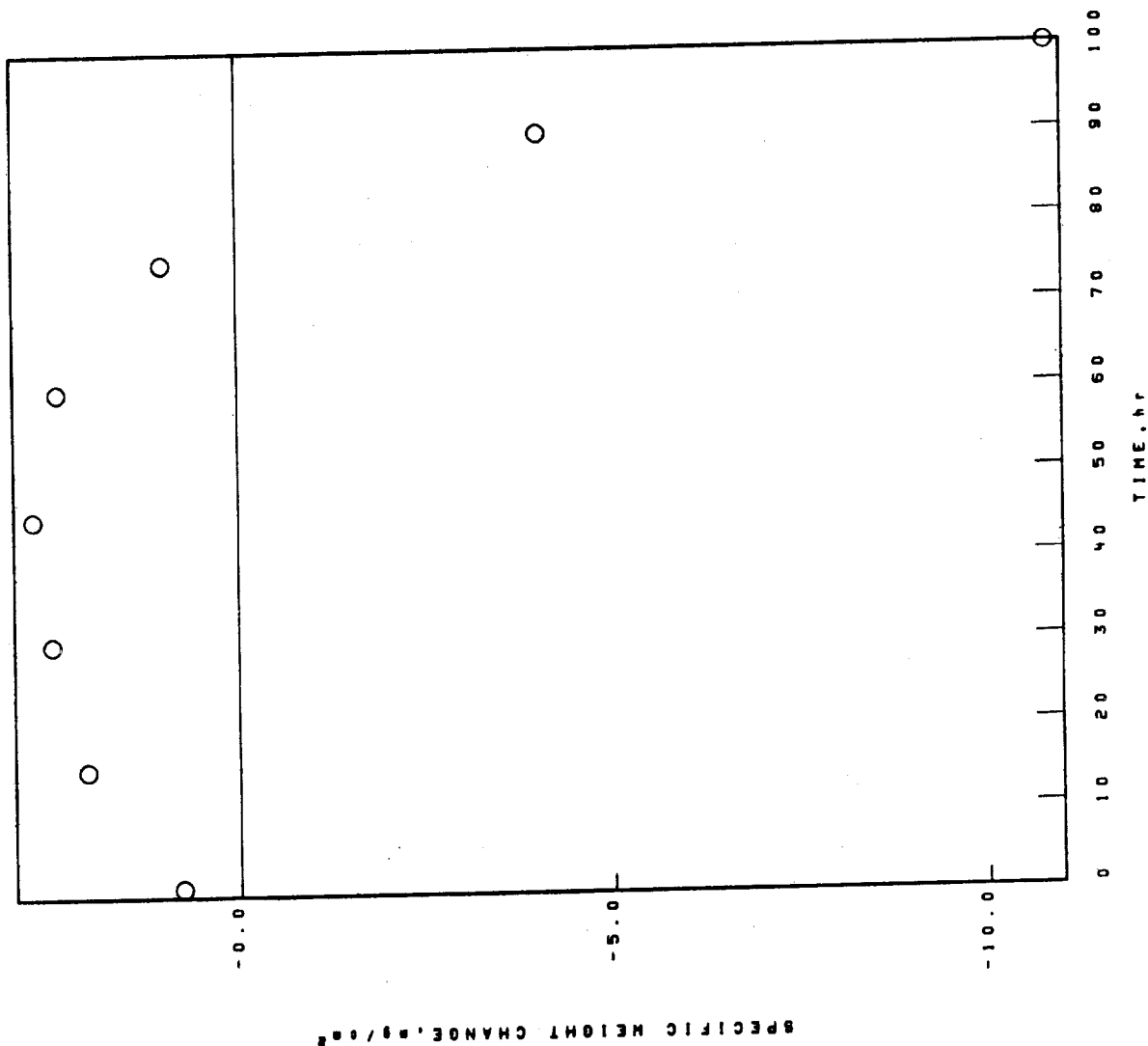
1.00hr

CYCLES

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	0.77
15.00	2.04
30.00	2.50
45.00	2.75
60.00	2.41
75.00	1.00
90.00	-4.03
100.00	-10.80



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-426-6  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

NIO

SPINEL. 80-8-10A.

TRI(RUTILE).4(110)>3-30A.

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NIO

TRI(RUTILE).4(110)>3-30A.

SPINEL. 80-8-10A.

NI(W.M.)O, TYPE I



STATIC AIR

THICK

TEST

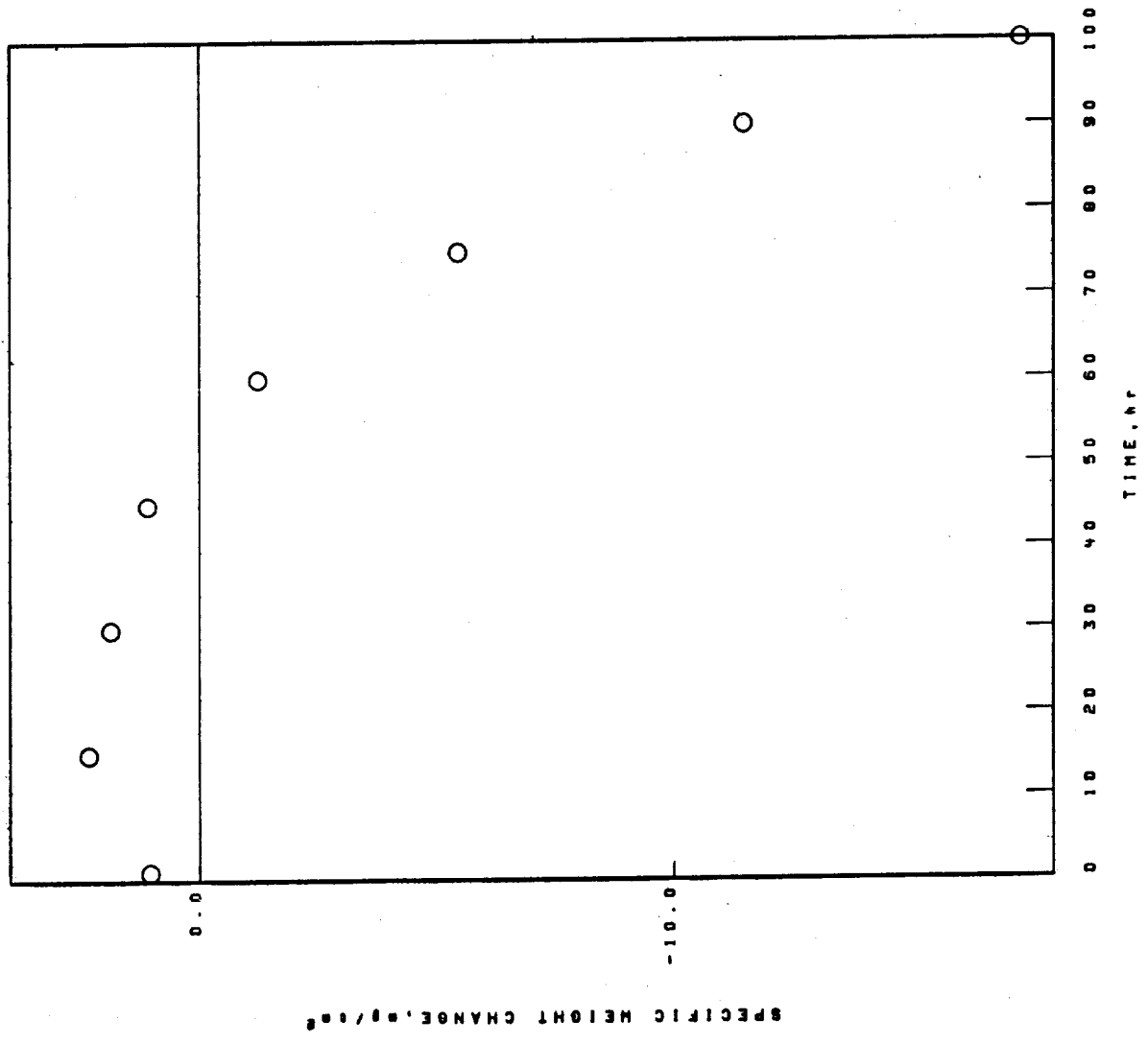
100.00hr

1150°C

1.00hr CYCLES

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔM/A, g/cm <sup>2</sup>
0.00	0.00
1.00	1.04
15.00	2.34
30.00	1.88
45.00	1.10
60.00	-1.23
75.00	-5.45
90.00	-11.47
100.00	-17.29

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-428-3  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

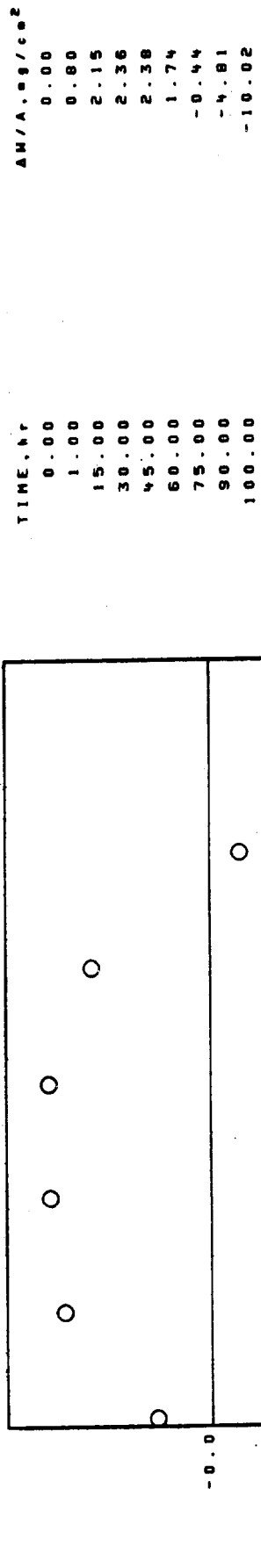
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. 00-8.10A.	NIO
NIO	TRI(RUTILE).4(110)>3.30A.
TRI(RUTILE).4(110)>3.30A.	SPINEL. 00-8.10A.
NIO(M.N.)0, TYPE 1	NIO(M.N.)0, TYPE 1

FACE CENTERED CUBIC MATRIX

NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR  
 02-04-019-428-6

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-428-6  
 TAZ-BA 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

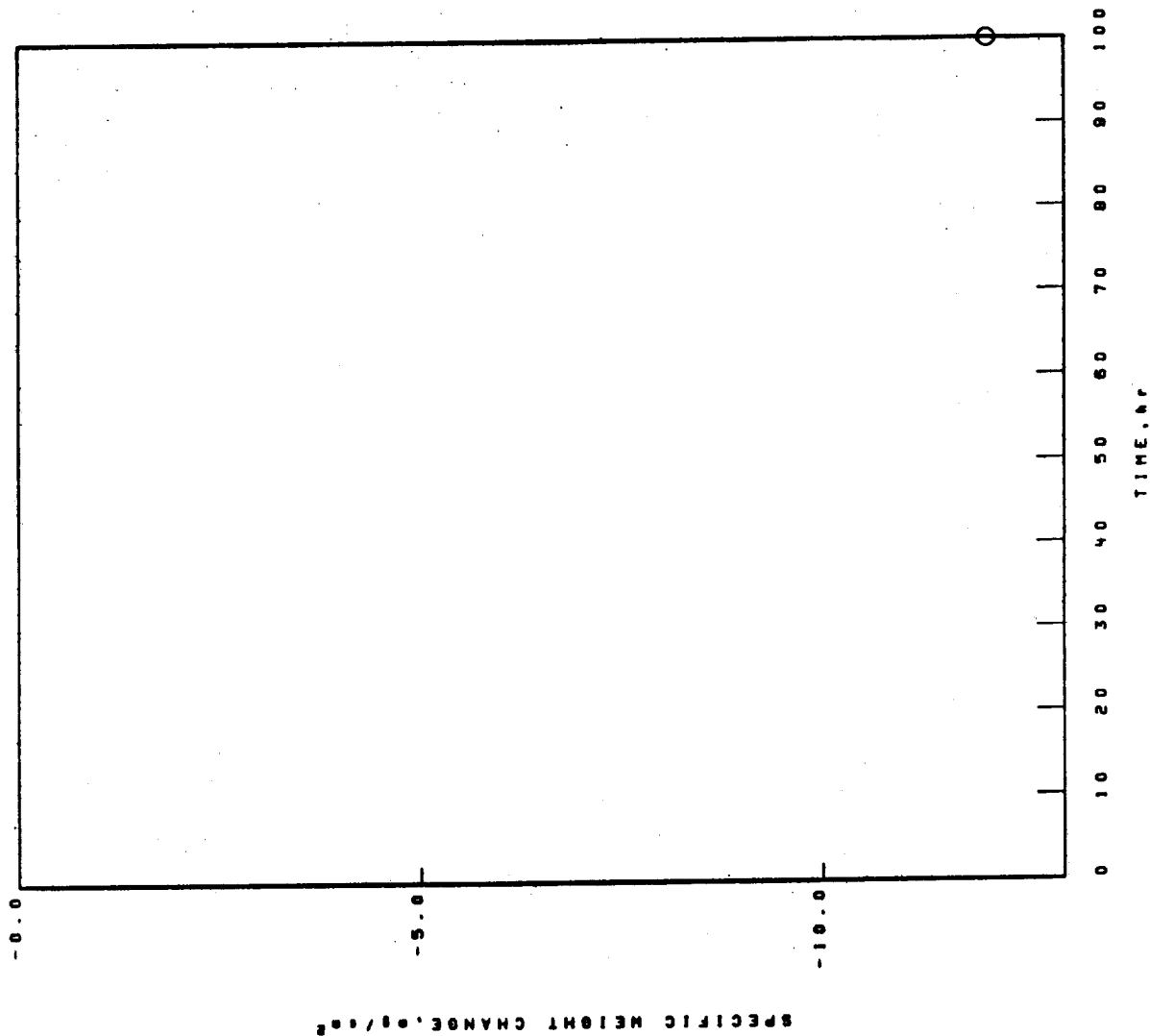
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. #0-8.10A.	NIO
NIO	TRI(RUTILE).4(110)>3.30A.
TRI(RUTILE).4(110)>3.30A.	SPINEL. #8-8.10A.
NI(W.M.)O, TYPE I	NI(W.M.)O, TYPE I

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-431-3  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



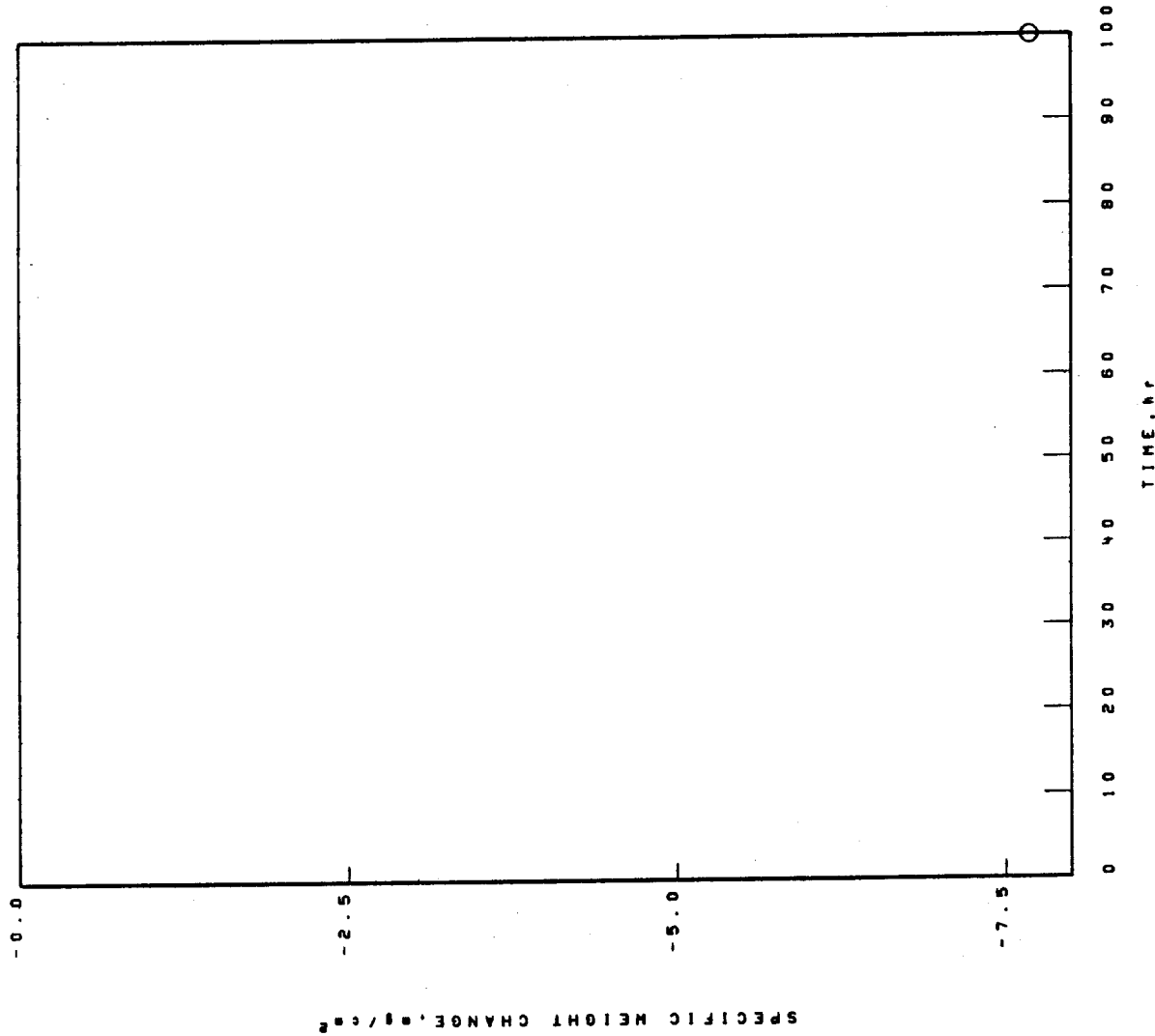
NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-019-431-3  
 TAZ-8A                      1150°C      1.00hr CYCLES      100.00hr TEST      2.302mm THICK      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	NIO
SPINEL, $\theta_0=8.10A$ .	SPINEL, $\theta_0=8.25A$ .
TRI(RUTILE).4(110)>3.30A.	NI(W.M.)O <sub>4</sub> TYPE I
	TRI(RUTILE).4(110)>3.30A.
FACE CENTERED CUBIC MATRIX	

NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-019-431-6  
 TAZ-8A                      1150°C                      1.00hr CYCLES                      100.00hr TEST                      2.296mm THICK                      STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cc <sup>2</sup>
0.00	0.00
100.00	-7.59

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-431-6  
 TAZ-BA 1150°C 1.00hr CYCLES 100.00hr TEST 2.296mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

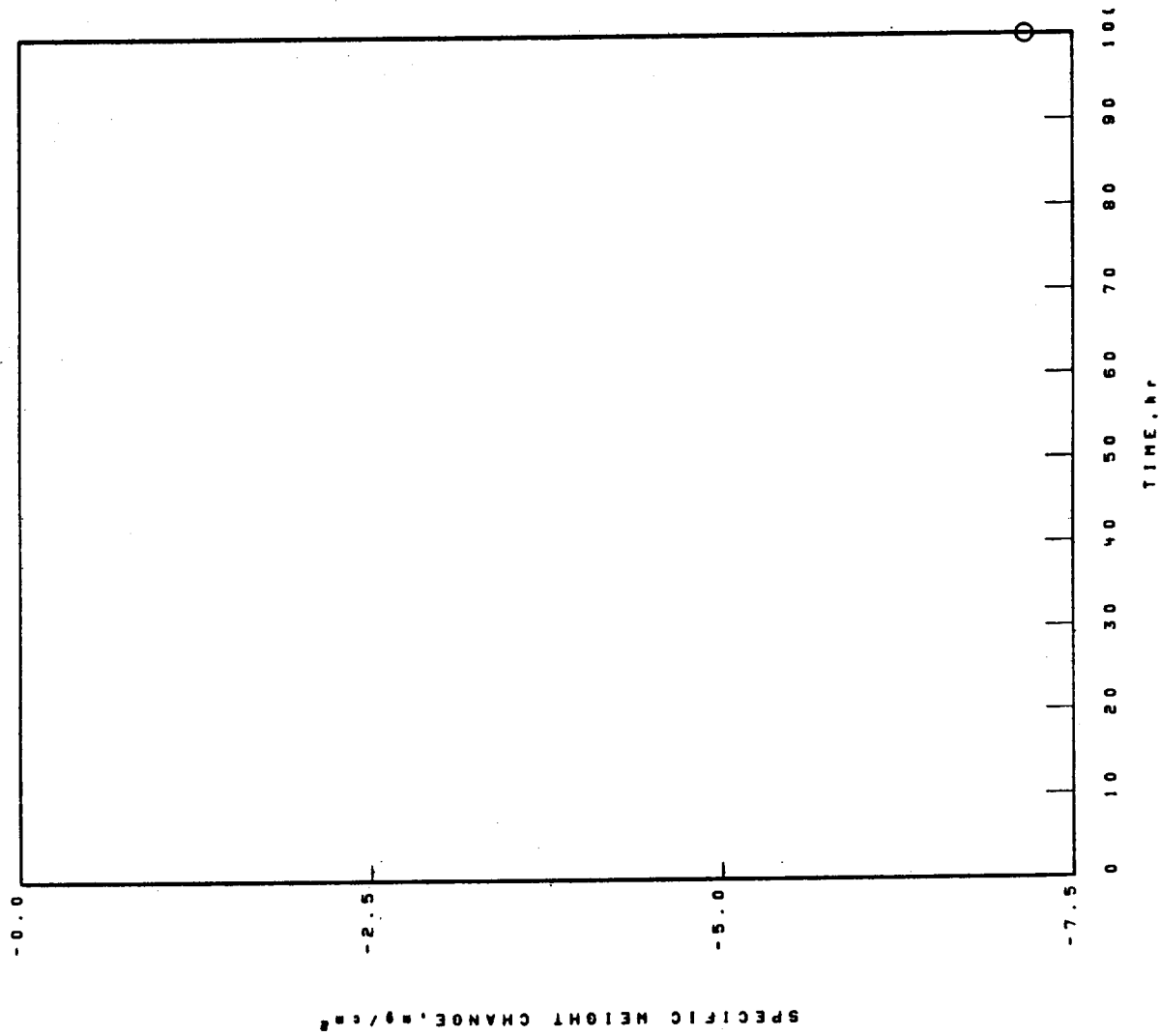
SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $\theta$ -8.10A.	NIO
TRI(RUTILE).4(110)>3.30A.	SPINEL, $\theta$ -8.25A.
NIO	NI(W.M.)O <sub>4</sub> TYPE I
	TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX



NI BASE      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS      02-04-019-432-3  
 TAZ-8A      1150°C      1.00hr CYCLES      100.00hr TEST      2.302mm THICK      STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
100.00	-7.16

NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-019-432-3  
 1A2-8A                      1150°C      1.00hr CYCLES      100.00hr TEST      2.302mm THICK      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0=8.10A$ .

NIO

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta_0=8.30A$ .

FACE CENTERED CUBIC MATRIX

SPALL

100 hr

COLLECTED SPALL

NIO

TRI(RUTILE).4(110)>3.30A.

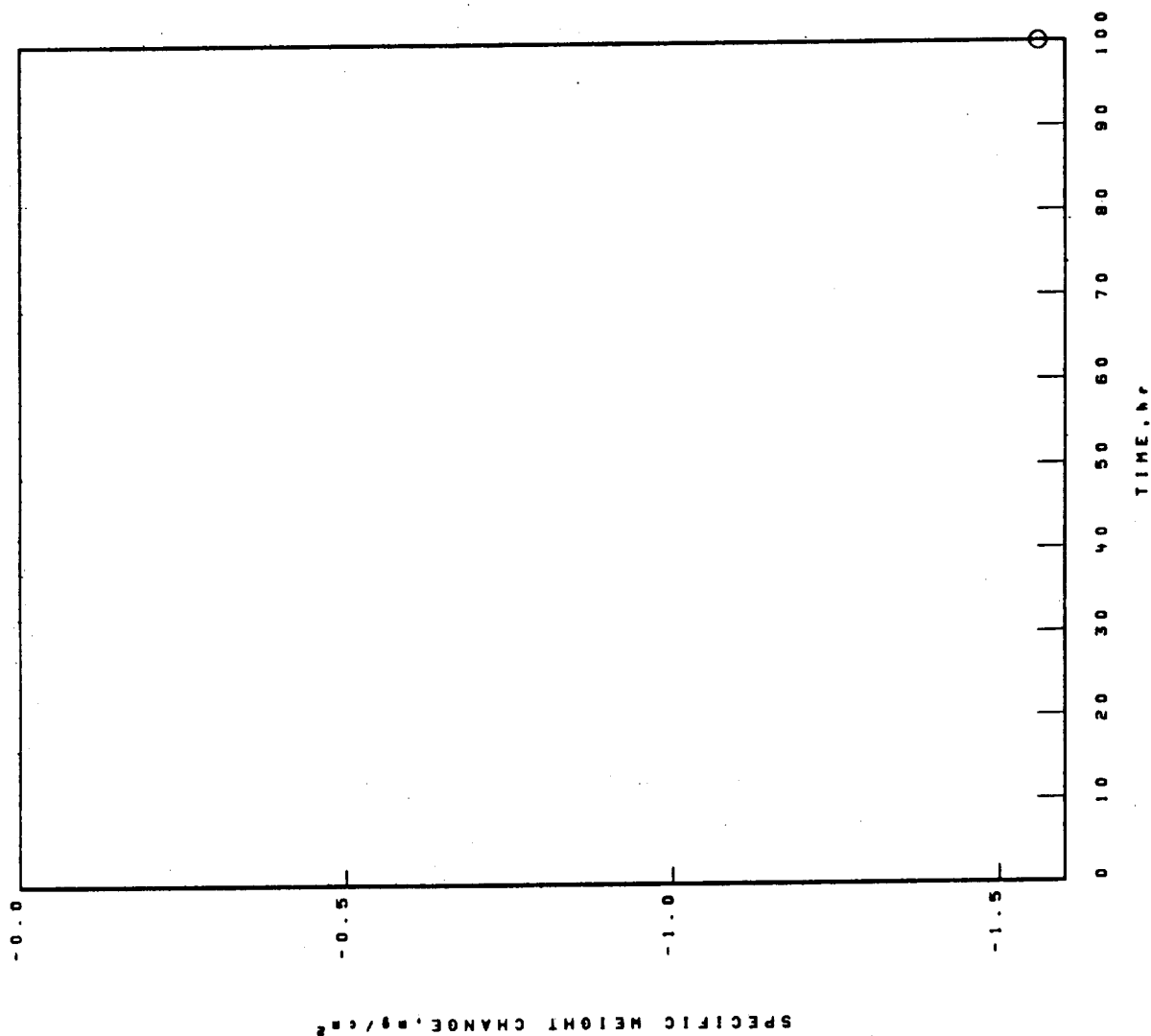
SPINEL.  $\theta_0=8.15A$ .

NI(M.M=10), TYPE I

SPINEL.  $\theta_0=8.30A$ .

NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.302mm THICK  
 STATIC AIR  
 02-04-019-432-6

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.302mm THICK STATIC AIR  
 02-04-019-432-8

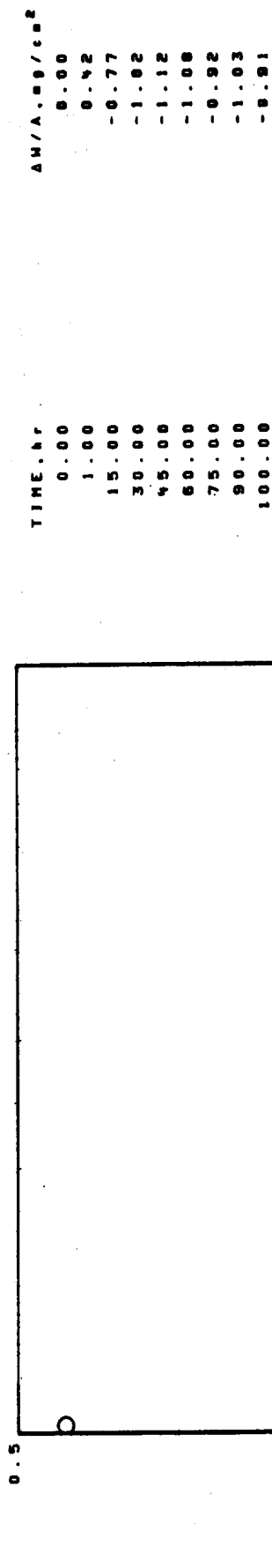
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $a_0=8.10\text{\AA}$ .	NiO
NiO	SPINEL. $a_0=8.30\text{\AA}$ .
TRI(RUTILE). $d(110)>3.30\text{\AA}$ .	TRI(RUTILE). $d(110)>3.30\text{\AA}$ .
SPINEL. $a_0=8.30\text{\AA}$ .	Cr <sub>2</sub> O <sub>3</sub>
Cr <sub>2</sub> O <sub>3</sub>	

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-472-2  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.272mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-472-2  
 TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.272mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 TRI(RUTILE).d(110)>3.30A.  
 SPINEL.  $\theta_0=8.10A$ .  
 NIO  
 Al<sub>2</sub>O<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPALL  
 1 hr  
 COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 NIO  
 TRI(RUTILE).d(110)>3.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.10A$ .  
 TRI(RUTILE).d(110)>3.30A.  
 Al<sub>2</sub>O<sub>3</sub>  
 NIO  
 SPINEL.  $\theta_0=8.25A$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 ZrO<sub>2</sub>  
 100 hr  
 COLLECTED SPALL  
 NIO  
 SPINEL.  $\theta_0=8.30A$ .  
 TRI(RUTILE).d(110)>3.30A.

FACE CENTERED CUBIC MATRIX

02-04-042-414-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST

1150°C

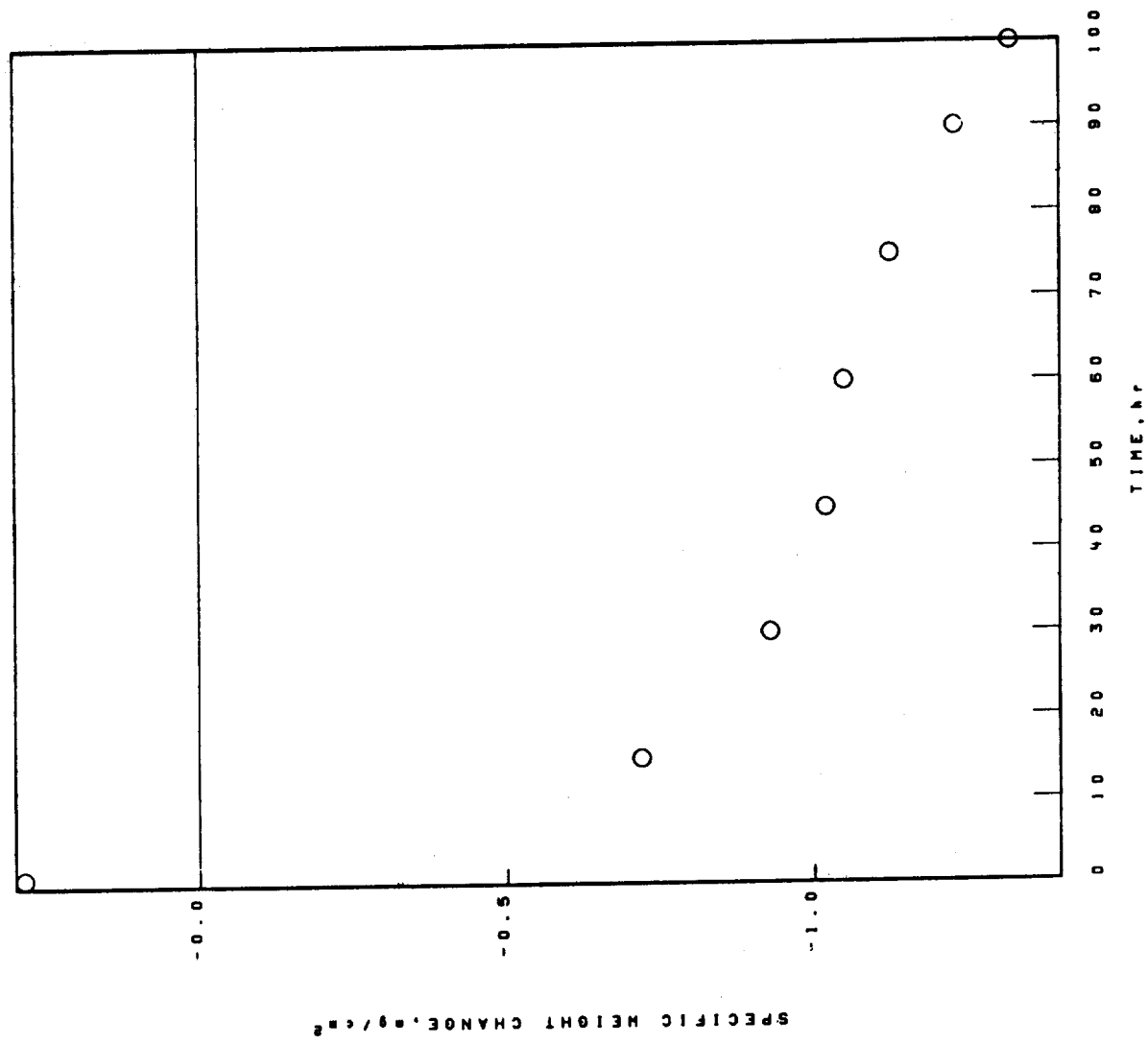
1.00hr CYCLES

100.00hr

DS-TAZ-8A

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	0.28
15.00	-0.72
30.00	-0.93
45.00	-1.02
60.00	-1.05
75.00	-1.12
90.00	-1.23
100.00	-1.32



NI BASE  
 DS-TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.320mm THICK STATIC AIR  
 02-04-042-414-1

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 SPINEL, 8-8-10A.  
 TRI(RUTILE).4(110)53.30A.  
 Al<sub>2</sub>O<sub>3</sub>  
 ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL, 8-8-30A.  
 TRI(RUTILE).4(110)53.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(M.M.10), TYPE 1  
 (Ni.C.F.)TiO<sub>2</sub>  
 TRI(RUTILE).4(110)53.30A.



COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

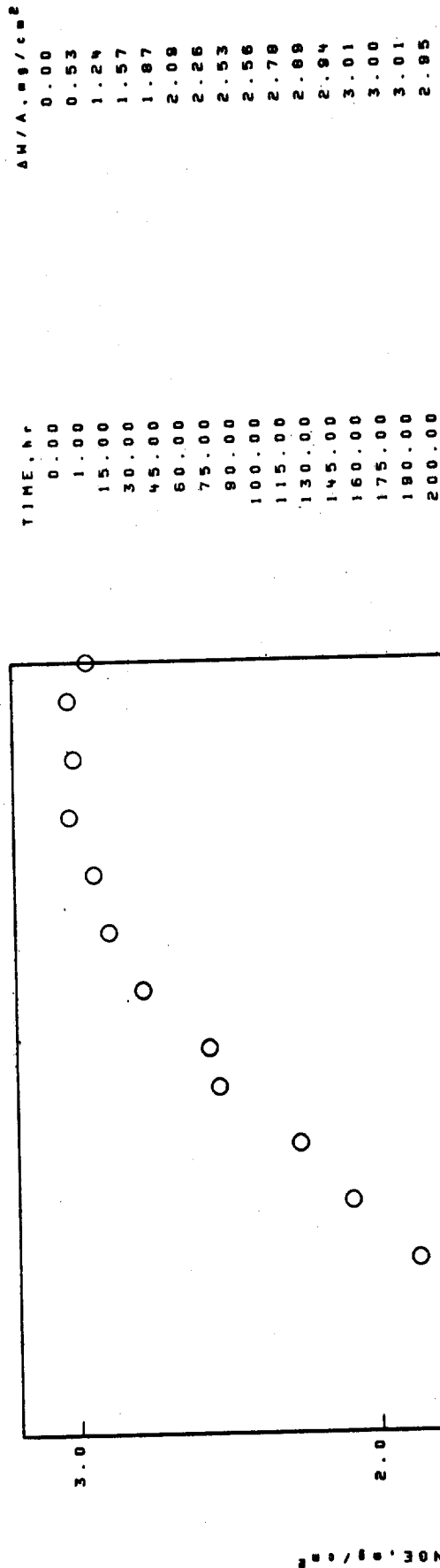
N1 BASE

STATIC AIR

1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK

TAZ-8A

SPECIFIC HEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

TAZ-8A

02-04-019-324-3

1100°C

1.00hr CYCLES

200.00hr TEST

2.315mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

SPINEL. 80-8.10A.

TRI(RUTILE). 4(110)>3.30A.

NiO

Ni(W.M.)O, TYPE 1

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

200 hr

COLLECTED SPALL

NiO

Ni(W.M.)O, TYPE 1

SPINEL. 80-8.25A.

SPINEL. 80-8.05A.

TRI(RUTILE). 4(110)>3.30A.

Al<sub>2</sub>O<sub>3</sub>

Ni(W.M.)O, TYPE 2

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

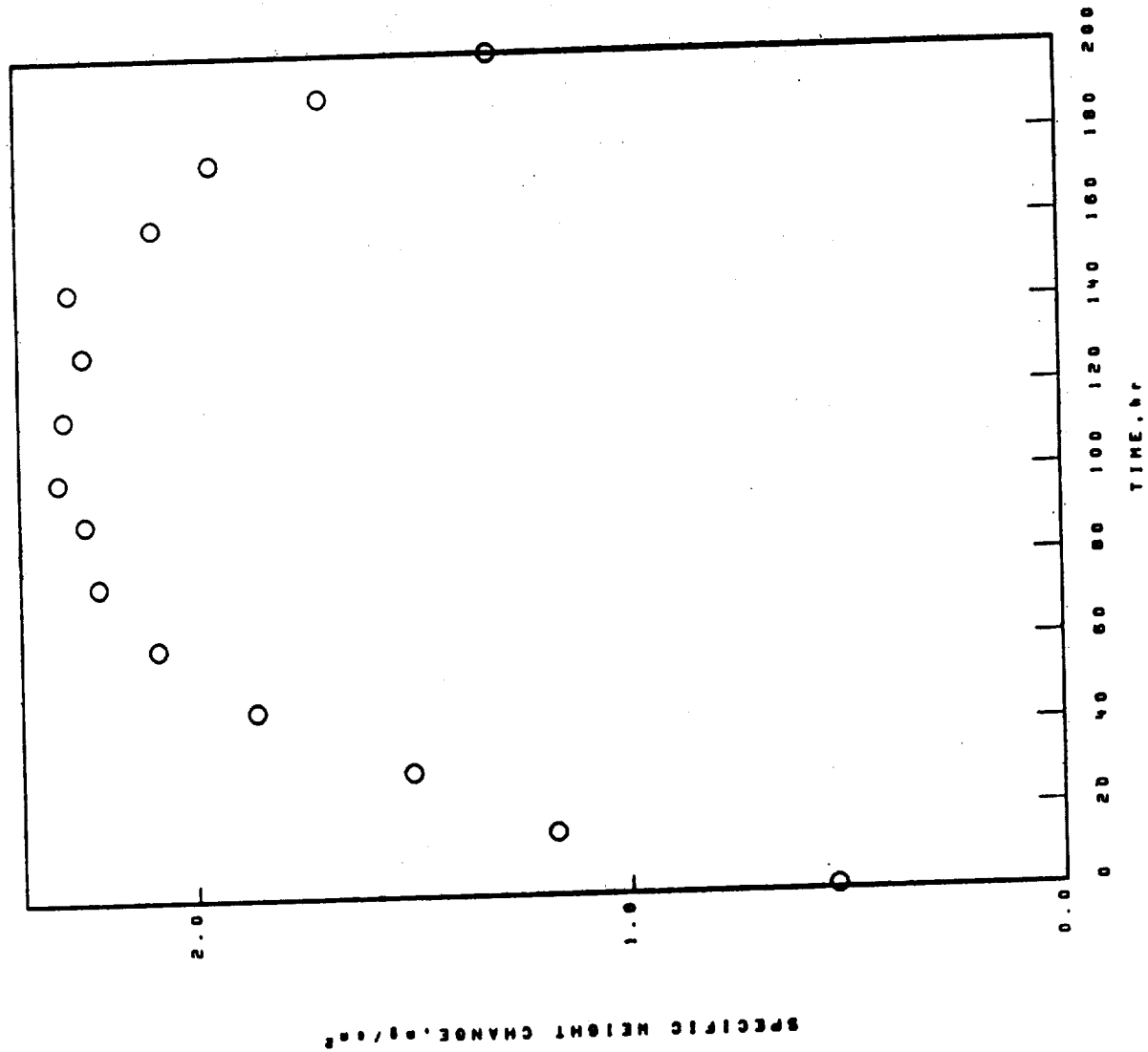
N1 BASE

TAZ-8A

1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.53
15.00	1.17
30.00	1.50
45.00	1.86
60.00	2.09
75.00	2.22
90.00	2.25
100.00	2.31
115.00	2.30
130.00	2.25
145.00	2.28
160.00	2.08
175.00	1.95
190.00	1.70
200.00	1.31



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.324mm THICK  
 02-04-019-413-6  
 STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr  
 STANDARD SURFACE  
 SPINEL, 80-8.10A.  
 TRI(RUTILE).4(110)>3.30A.  
 ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL  
 200 hr  
 COLLECTED SPALL  
 NiO  
 Ni(W.M.)O, TYPE I  
 SPINEL, 80-8.25A.  
 TRI(RUTILE).4(110)>3.30A.

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

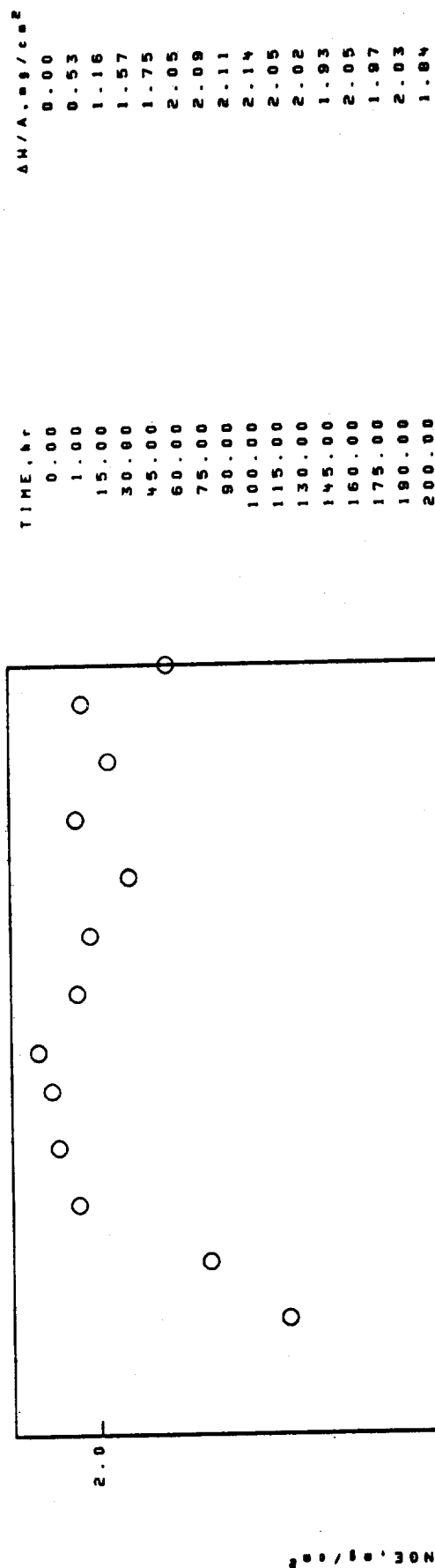
THICK

TEST 2.296

1100°C 1.00hr CYCLES 200.00hr

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-469-2  
 TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.296mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL. #8-8.10A.

NiO

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. #8-8.10A.

TRI(RUTILE).4(110)>3.30A.

NiO

ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. #8-8.10A.

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

SPINEL. #8-8.30A.

SPINEL. #8-8.10A.

Cr<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

200 hr

PROBABLE CROSS-SPALL

SPINEL. #8-8.30A.

CoO

CoWO<sub>4</sub>, 15-867

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

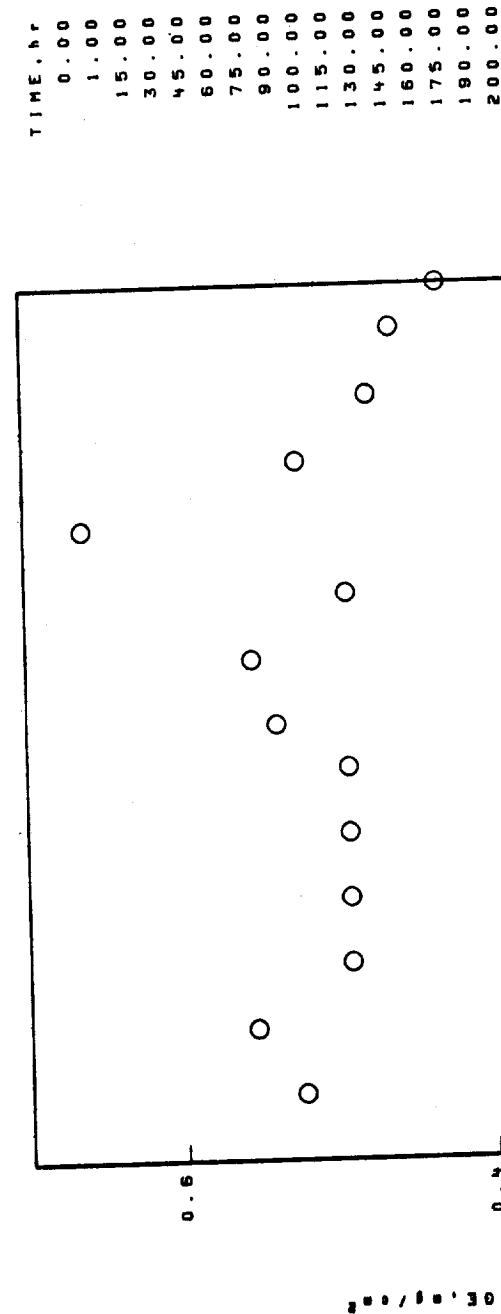
STATIC AIR

2.260mm THICK

1100°C 1.00hr CYCLES 200.00hr TEST

TAZ-8A

## SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-473-2  
TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.260mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8.10A.

TRI(RUTILE).4(110)>3.30A.

ZrO<sub>2</sub>

100 hr

COLLECTED SPALL

NiO

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8.25A.

SPINEL. 80-8.10A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 80-8.10A.

TRI(RUTILE).4(110)>3.30A.

Al<sub>2</sub>O<sub>3</sub>

NiO

ZrO<sub>2</sub>

200 hr

COLLECTED SPALL

NiO

SPINEL. 80-8.25A.

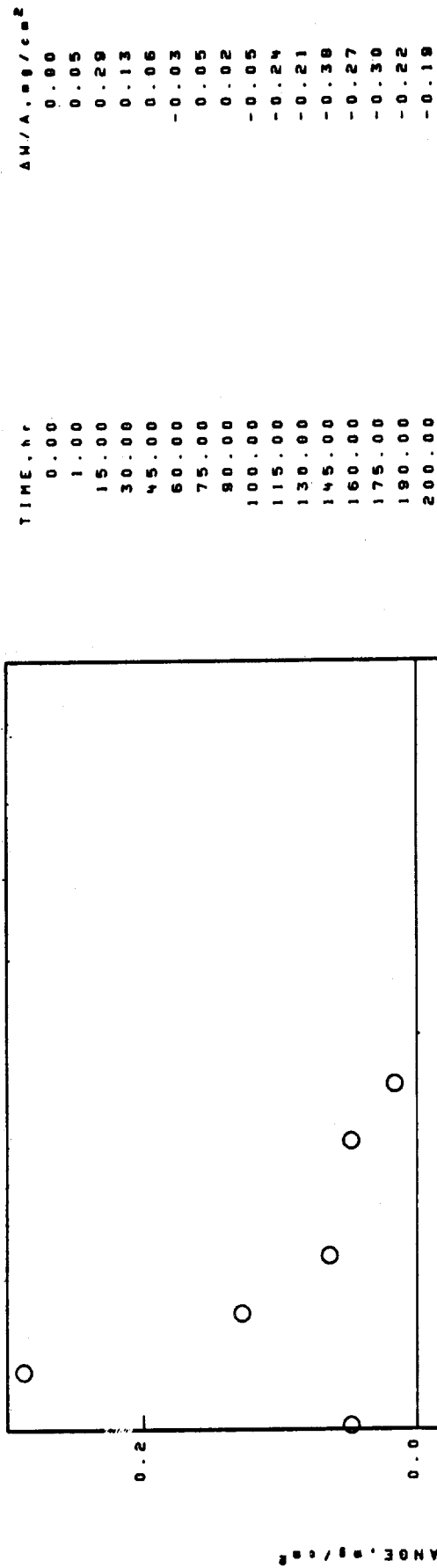
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.326mm THICK  
 STATIC AIR  
 02-04-019-657-6

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-657-6

TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.326mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL  
1 hr  
STANDARD SURFACE  
TRI(RUTILE).4(110)13.30A.  
NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
100 hr  
STANDARD SURFACE  
SPINEL. 80-8.10A.  
TRI(RUTILE).4(110)13.30A.  
Al<sub>2</sub>O<sub>3</sub>  
NiO  
COLLECTED SPALL  
NiO  
SPINEL. 80-8.25A.  
TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX  
200 hr  
STANDARD SURFACE  
SPINEL. 80-8.10A.  
TRI(RUTILE).4(110)13.30A.  
Al<sub>2</sub>O<sub>3</sub>  
FACE CENTERED CUBIC MATRIX  
200 hr  
PROBABLE CROSS-SPALL  
NiO  
SPINEL. 80-8.25A.  
TRI(RUTILE).4(110)13.30A.  
Cr<sub>2</sub>O<sub>3</sub>

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

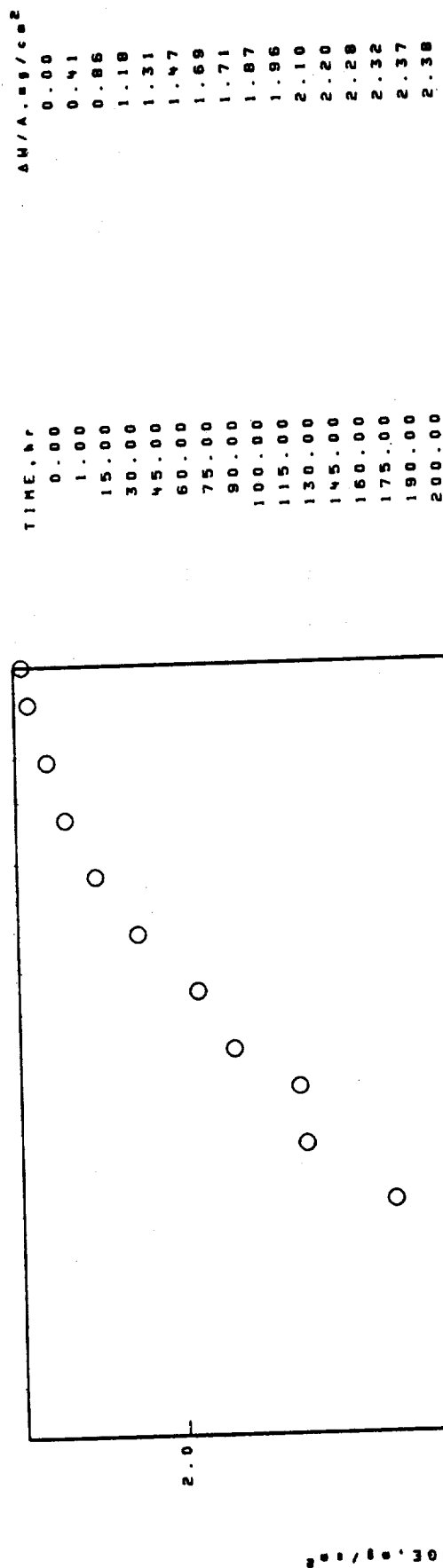
NI BASE

STATIC AIR

1100°C 1.00hr CYCLES 200.00hr TEST 2.314mm THICK

TAZ-8A

## SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.314mm THICK  
 02-04-018-679-3  
 STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

SPINEL.  $\theta$ -8.25A.

ZrO<sub>2</sub>

NiO

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta$ -8.10A.

NiO

ZrO<sub>2</sub>

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

100 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta$ -8.30A.

SPINEL.  $\theta$ -8.10A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta$ -8.10A.

TRI(RUTILE).4(110)>3.30A.

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

200 hr

PROBABLE CROSS-SPALL

NiO

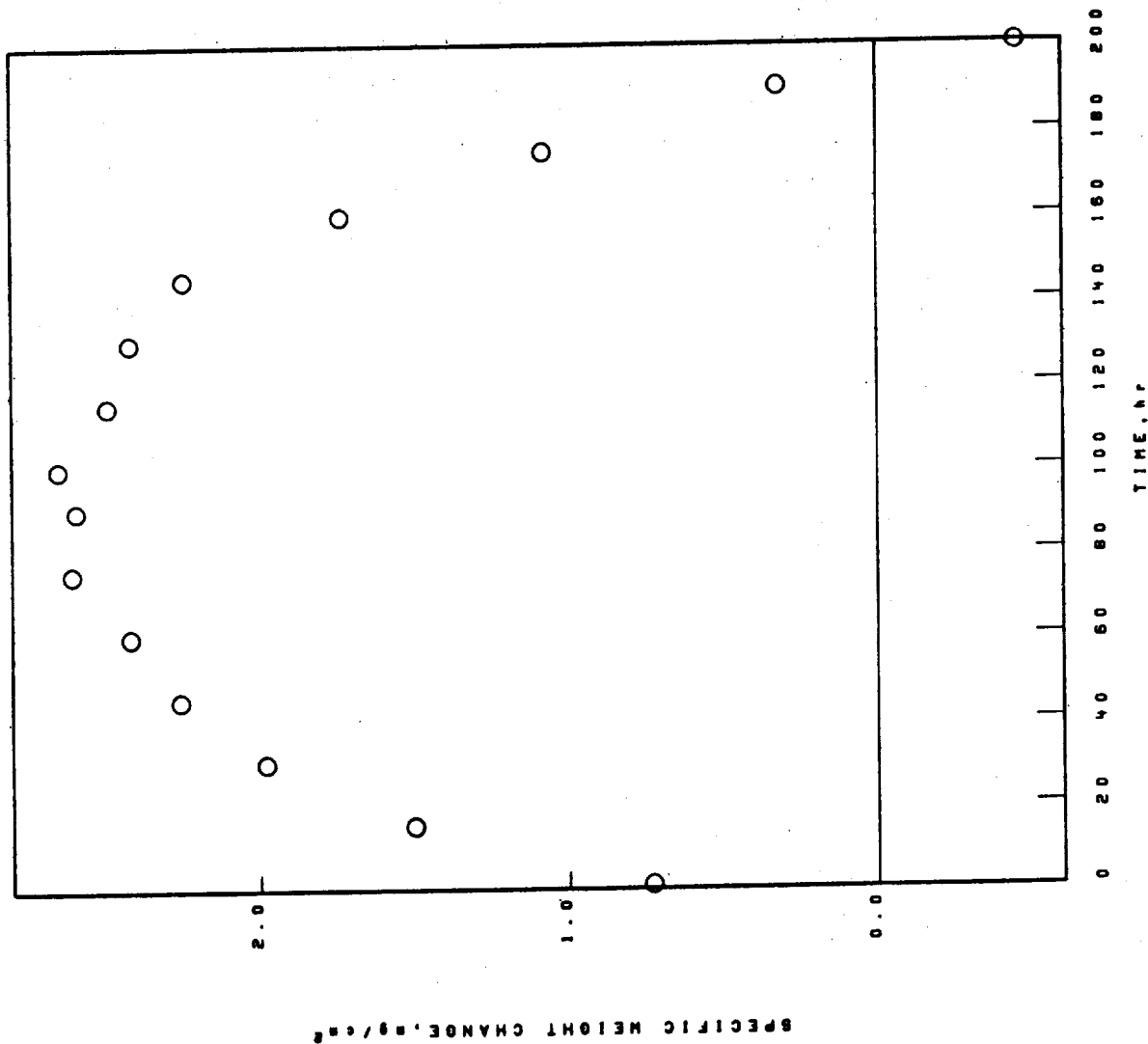
SPINEL.  $\theta$ -8.35A.

TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 TAZ-8A  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.314mm THICK STATIC AIR  
 02-04-019-679-6

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔM/A, mg/cm²
0.00	0.00
1.00	0.73
15.00	1.50
30.00	1.98
45.00	2.26
60.00	2.42
75.00	2.61
90.00	2.59
100.00	2.65
115.00	2.49
130.00	2.42
145.00	2.24
160.00	1.73
175.00	1.08
190.00	0.32
200.00	-0.45

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-018-679-8  
 TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.314mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 TRI(RUTILE).4(110)>3.30A.  
 NIO  
 SPINEL. 8-8.20A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 ZrO<sub>2</sub>

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 8-8.10A.  
 NIO  
 TRI(RUTILE).4(110)>3.30A.  
 SPINEL. 8-8.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Al<sub>2</sub>O<sub>3</sub>

100 hr

PROBABLE CROSS-SPALL

NIO

SPINEL. 8-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 8-8.10A.

TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 SPINEL. 8-8.10A.  
 NIO  
 TRI(RUTILE).4(110)>3.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 ZrO<sub>2</sub>

200 hr

PROBABLE CROSS-SPALL

NIO

SPINEL. 8-8.35A.

TRI(RUTILE).4(110)>3.30A.

02-04-019-680-3

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

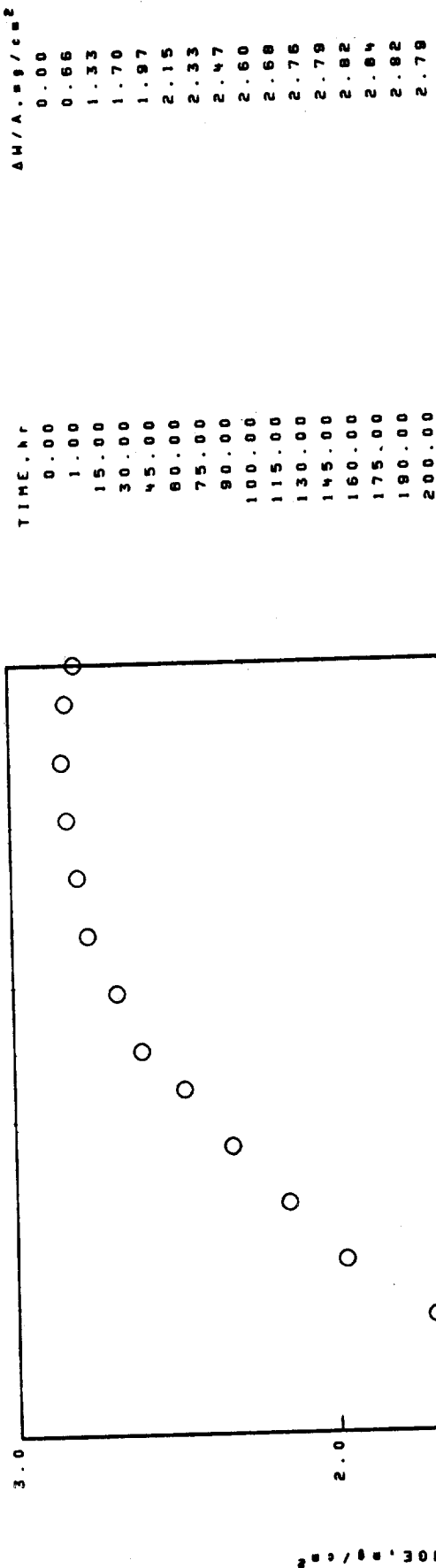
NI BASE

STATIC AIR

1100°C 1.00hr CYCLES 200.00hr TEST 2.314mm THICK

TAZ-8A

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-019-680-3

TAZ-8A

1100°C 1.00hr CYCLES 200.00hr TEST 2.314mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL. 00-8.25A.

Cr<sub>2</sub>O<sub>3</sub>

NiO

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. 00-8.10A.

NiO

TRI(RUTILE).4(110)>3.30A.

SPINEL. 00-8.30A.

TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

PROBABLE CROSS-SPALL

NiO

SPINEL. 00-8.30A.

(Ni,Cr,F)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)>3.30A.

TRI(RUTILE).4(110)>3.30A.

200 hr

PROBABLE CROSS-SPALL

NiO

SPINEL. 00-8.35A.

SPINEL. 00-8.10A.

TRI(RUTILE).4(110)>3.30A.



# COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

**STATIC AIR**

THICK

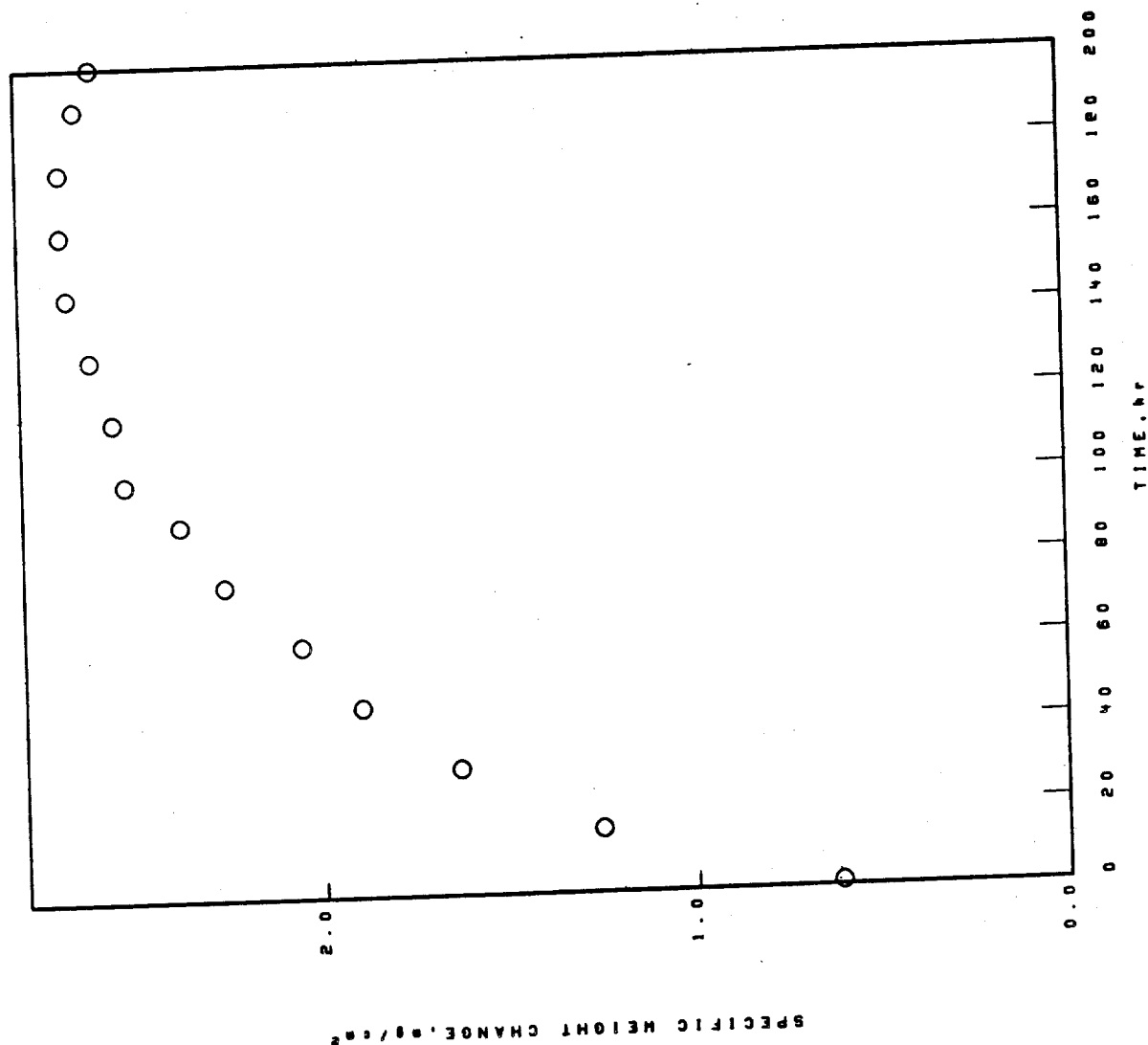
**TEST**

5373

•

T A Z - B A

**SPECIFIC WEIGHT CHANGE DATA**



TIME, hr	$\Delta H/A, \text{ g/cm}^2$
0.00	0.00
1.00	0.51
15.00	1.25
30.00	1.63
45.00	1.90
60.00	2.06
75.00	2.26
90.00	2.38
100.00	2.52
115.00	2.55
130.00	2.61
145.00	2.67
160.00	2.68
175.00	2.68
190.00	2.67
200.00	2.60

NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-019-680-6

TAZ-6A

1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta$ -8.25A.

Cr<sub>2</sub>O<sub>3</sub>

NiO

Al<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta$ -8.10A.

NiO

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta$ -8.30A.

TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta$ -8.10A.

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta$ -8.30A.

(M.I.C.F.)TiO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

SPINEL.  $\theta$ -8.10A.

TRI(RUTILE).4(110)>3.30A.

TRI(RUTILE).4(110)>3.30A.

200 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta$ -8.35A.

SPINEL.  $\theta$ -8.15A.

TRI(RUTILE).4(110)>3.30A.

## COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

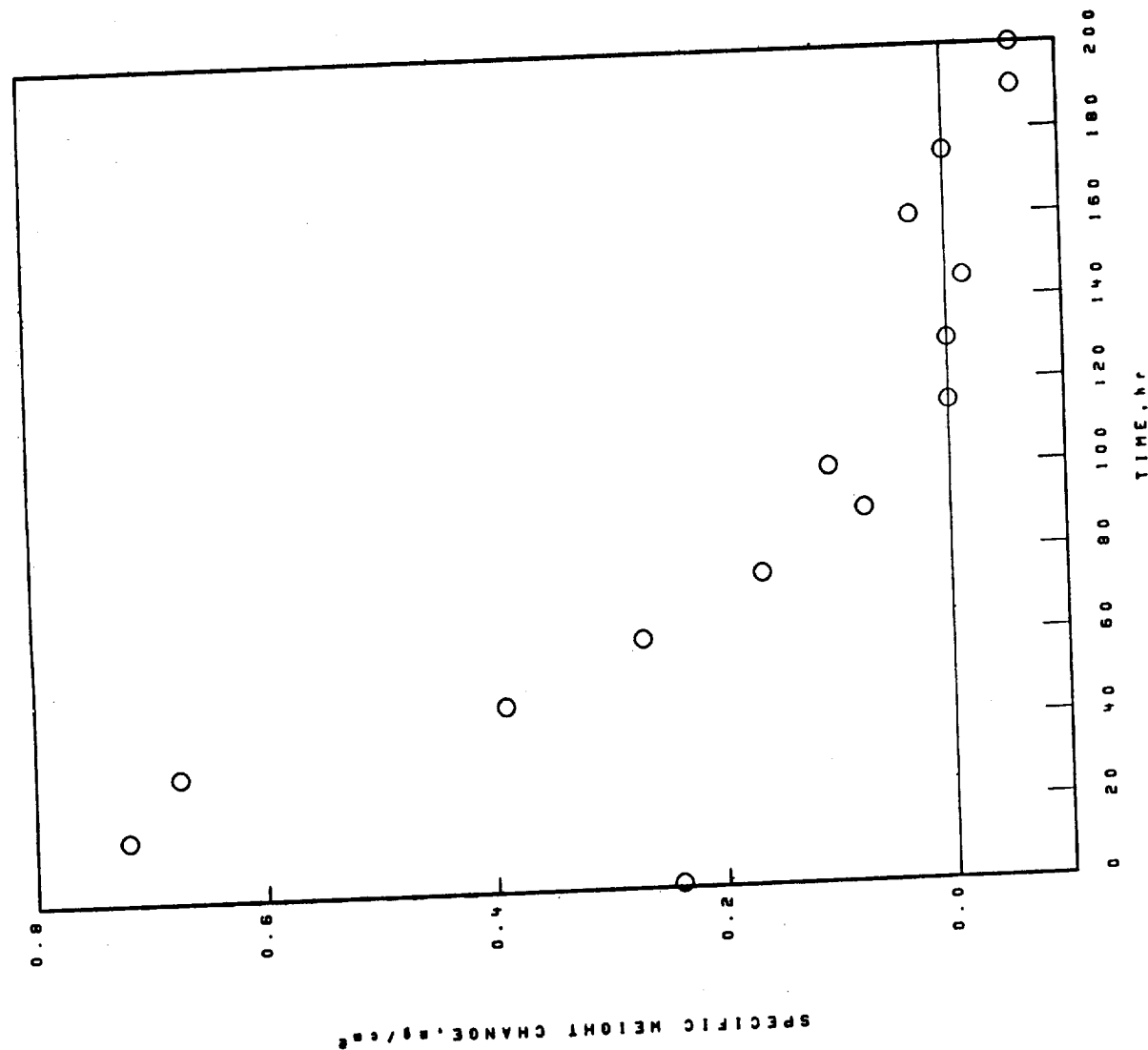
N1 BASE

DS-TAZ-8A

1100°C 1.00hr CYCLES 200.00hr TEST 2.320mm THICK

STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

DS-TAZ-8A

02-04-042-413-1

1100°C

1.00hr CYCLES

200.00hr TEST

2.320mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

SPINEL.  $\theta$  = 8.05A.

TRI(RUTILE).  $\theta$  (110)  $\gg$  3.30A.

Al<sub>2</sub>O<sub>3</sub>

NiO

SPALL

200 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta$  = 8.25A.

SPINEL.  $\theta$  = 8.10A.

TRI(RUTILE).  $\theta$  (110)  $\gg$  3.30A.

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

TAZ-8A

STATIC AIR

THICK

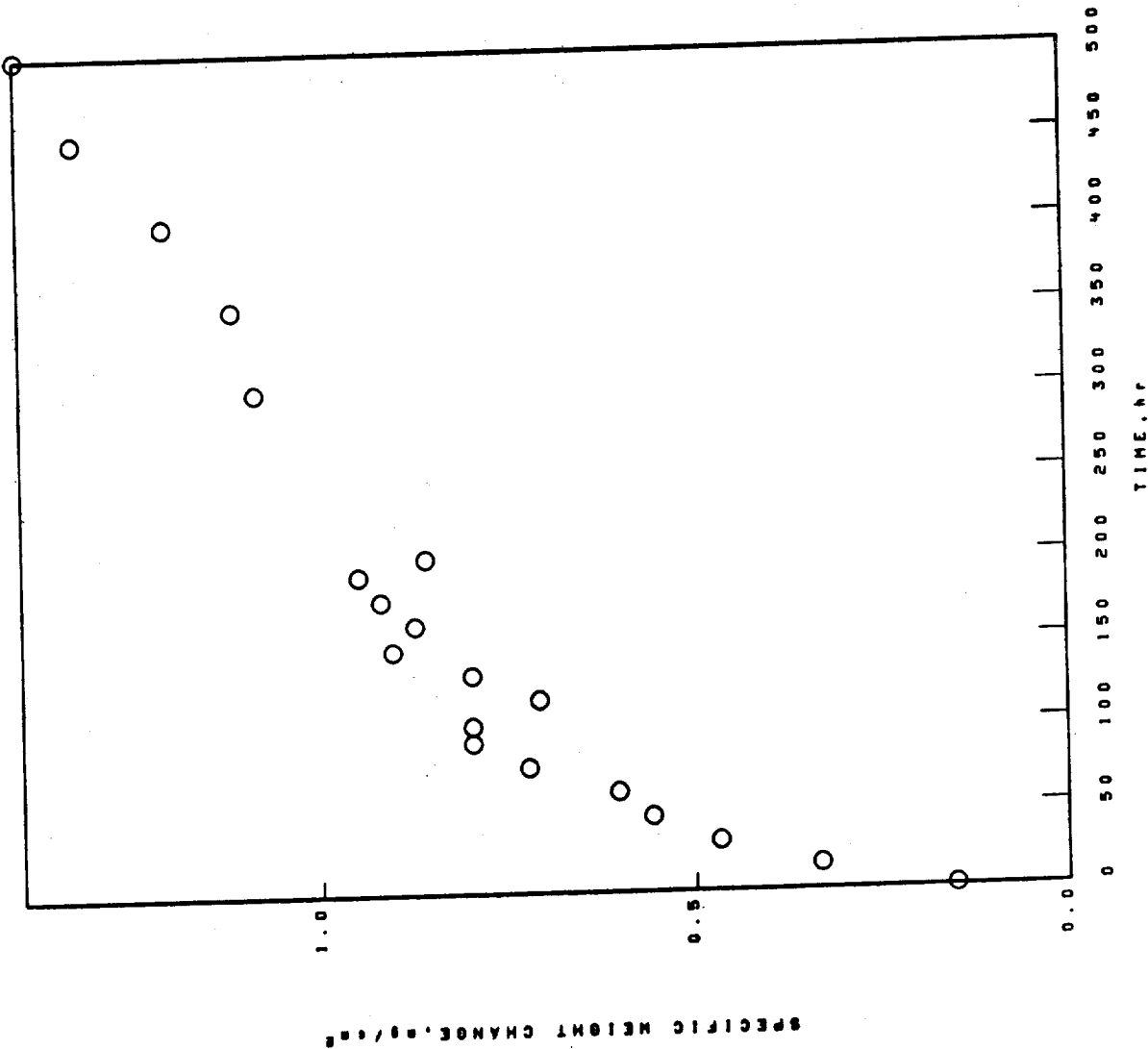
500.00hr TEST

1.00hr CYCLES

1000°C

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.15
15.00	0.33
30.00	0.47
45.00	0.56
60.00	0.60
75.00	0.72
90.00	0.80
100.00	0.80
115.00	0.71
130.00	0.80
145.00	0.90
160.00	0.87
175.00	0.92
190.00	0.95
200.00	0.86
250.00	0.84
300.00	1.08
350.00	1.11
400.00	1.20
450.00	1.32
500.00	1.40



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-471-6  
TAZ-8A 1000°C 1.00hr CYCLES 500.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta_0=8.10A$ .

ZrO<sub>2</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta_0=8.10A$ .

Al<sub>2</sub>O<sub>3</sub>

NI<sub>2</sub>O

ZrO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)>3.30A.

TRI(RUTILE).4(110)>3.30A.

SPINEL.  $\theta_0=8.10A$ .

NI<sub>2</sub>O

Cr<sub>2</sub>O<sub>3</sub>

ZrO<sub>2</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

500 hr

SECOND SURFACE PHASE

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $\theta_0=8.10A$ .

NI<sub>2</sub>O

TRI(RUTILE).4(110)>3.30A.

TRI(RUTILE).4(110)>3.30A.

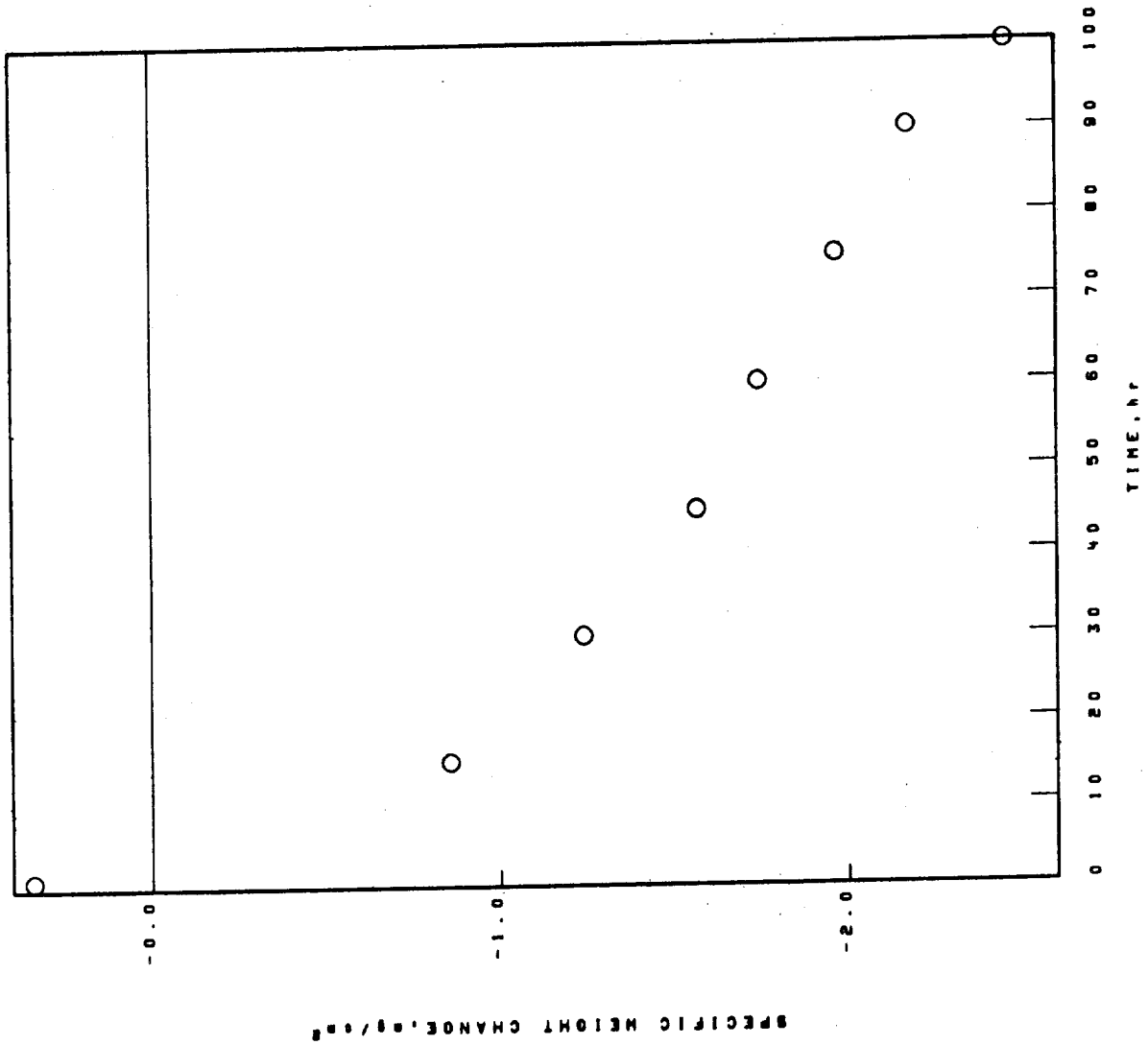
Cr<sub>2</sub>O<sub>3</sub>

NO SIGNIFICANT SPALL OBSERVED

NI BASE  
 TRM-R  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.338mm THICK  
 STATIC AIR  
 02-04-032-322-2

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.34
15.00	-0.86
30.00	-1.24
45.00	-1.57
60.00	-1.75
75.00	-1.97
90.00	-2.17
100.00	-2.46



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-322-2  
 TRW-R 1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $a_0 = 8.10\text{\AA}$ .

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).  $d(110) \leq 3.30\text{\AA}$ .

HfO<sub>2</sub>

SPALL

100 hr

COLLECTED SPALL

NI0

SPINEL.  $a_0 = 8.30\text{\AA}$ .

TRI(RUTILE).  $d(110) \leq 3.30\text{\AA}$ .

SPINEL.  $a_0 = 8.10\text{\AA}$ .

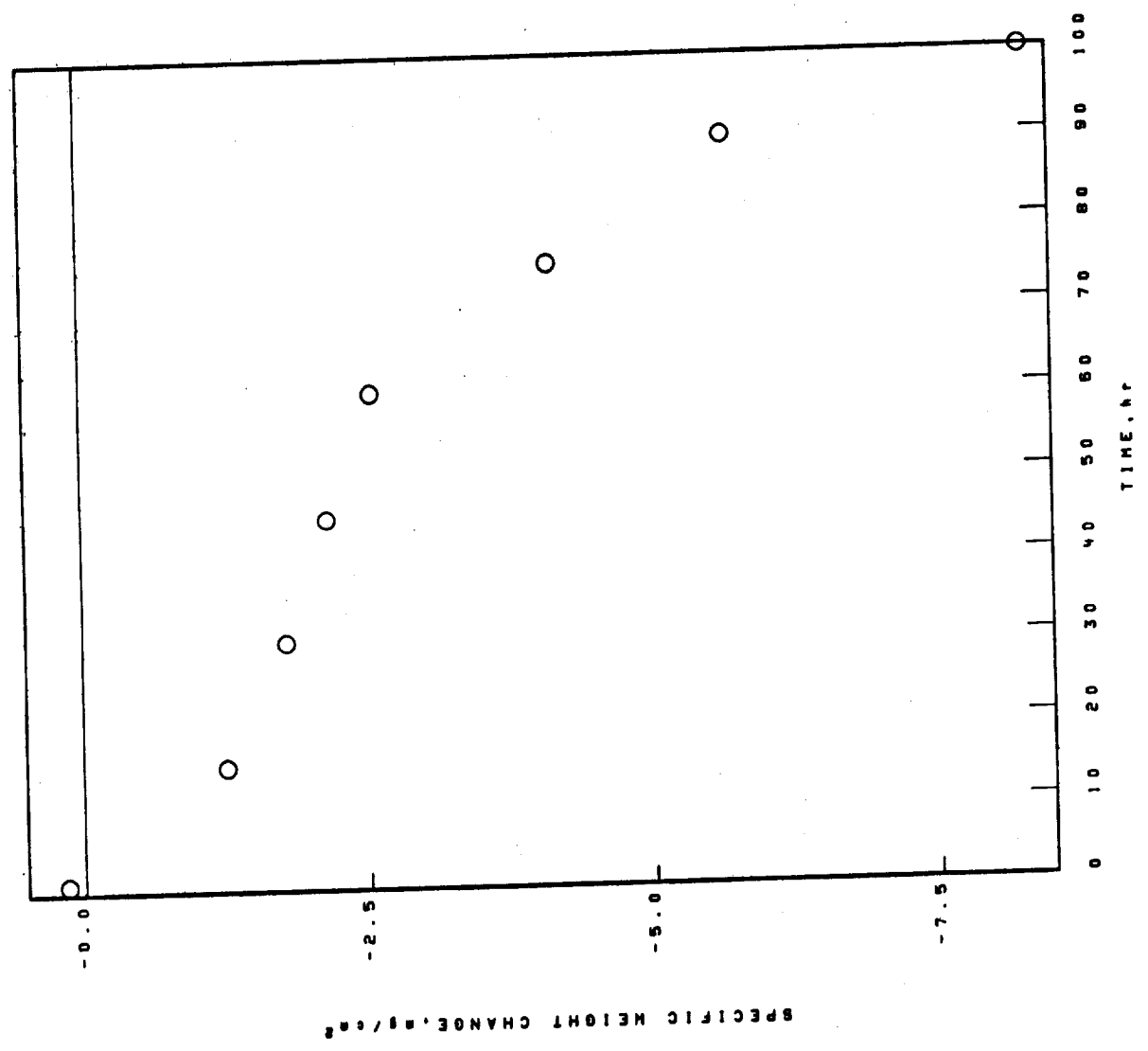
FACE CENTERED CUBIC MATRIX



NT BASE  
 TRM-R  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.334mm THICK STATIC AIR  
 02-04-032-474-2

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.15
15.00	-1.25
30.00	-1.78
45.00	-2.15
60.00	-2.55
75.00	-4.12
90.00	-5.65
100.00	-8.26



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-474-2  
 TRW-R 1150°C 1.00hr CYCLES 100.00hr TEST 2.334mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 TRI(RUTILE).4(110)3.30A.  
 SPINEL.  $\theta_0$ =8.10A.  
 SPINEL.  $\theta_0$ =8.25A.  
 Al<sub>2</sub>O<sub>3</sub>  
 HfO<sub>2</sub>  
 Cr<sub>2</sub>O<sub>3</sub>

SPALL  
 1 hr  
 COLLECTED SPALL  
 NIO  
 SPINEL.  $\theta_0$ =8.25A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta_0$ =8.10A.  
 HfO<sub>2</sub>  
 TRI(RUTILE).4(110)3.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 COLLECTED SPALL  
 NIO  
 TRI(RUTILE).4(110)3.30A.  
 SPINEL.  $\theta_0$ =8.25A.  
 SPINEL.  $\theta_0$ =8.10A.

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK 2.335mm

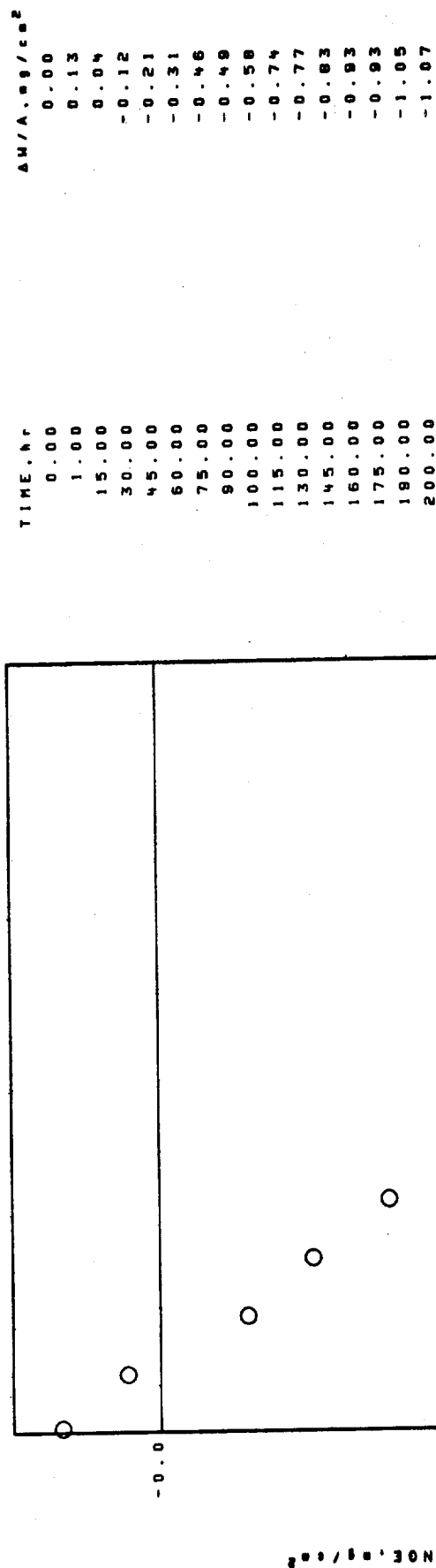
TEST 200.00hr

1.00hr CYCLES

1100°C

TRM-R

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-325-2  
 TRW-R 1100°C 1.00hr CYCLES 200.00hr TEST 2.335mm THICK STATIC AIP

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 SPINEL,  $\theta$ -8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE),  $\theta$ (110)13.30A.  
 HfO<sub>2</sub>  
 FACE CENTERED CUBIC MATRIX

SPALL  
 200 hr  
 COLLECTED SPALL  
 HfO  
 SPINEL,  $\theta$ -8.30A.  
 TRI(RUTILE),  $\theta$ (110)13.30A.  
 SPINEL,  $\theta$ -8.05A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Al<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES, 4 VALUES  
 2.78A.

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST 2.339

200.00hr

1100°C

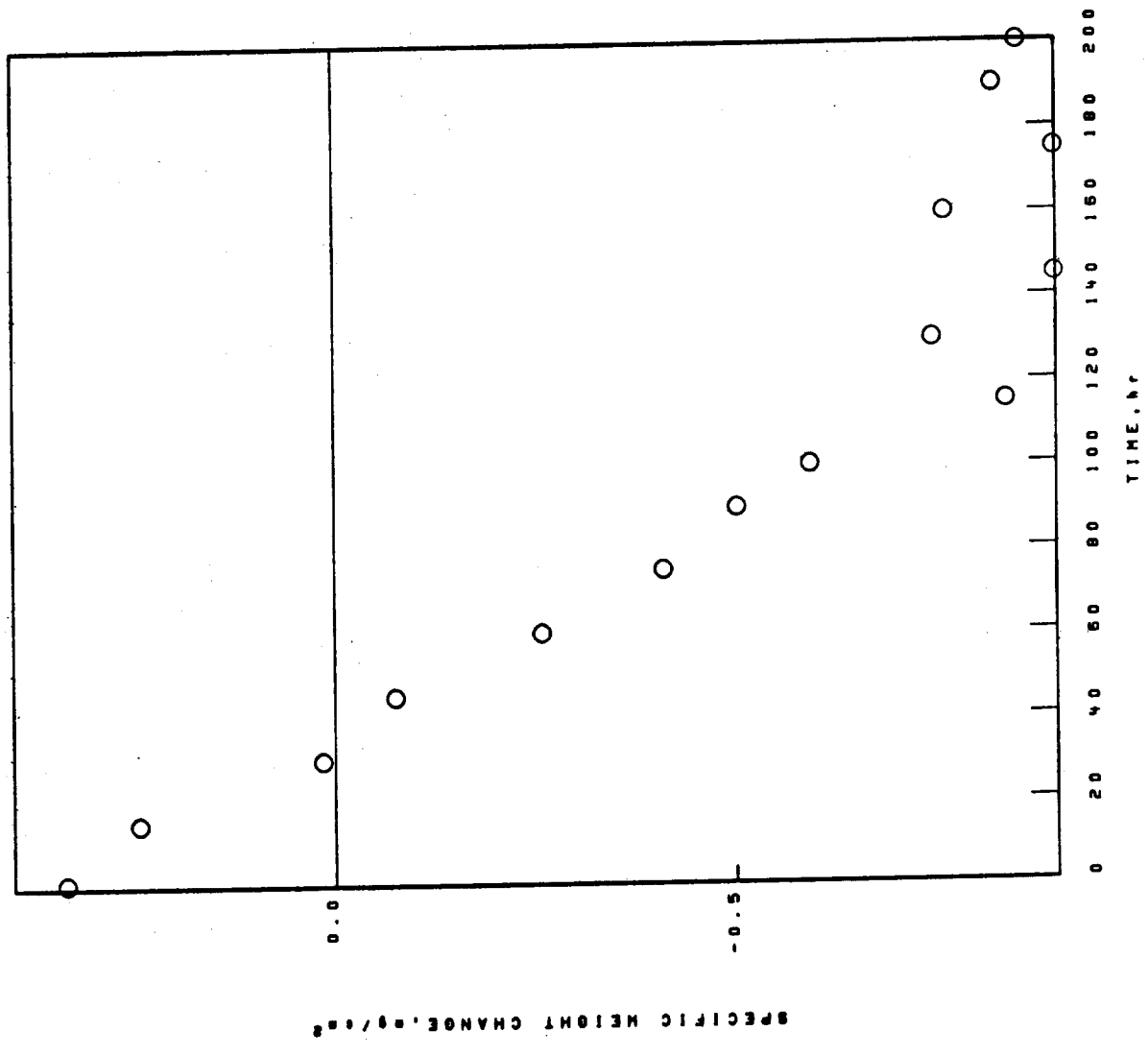
1.00hr

CYCLES

TRM-R

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.33
15.00	0.24
30.00	0.02
45.00	-0.08
60.00	-0.26
75.00	-0.41
90.00	-0.50
100.00	-0.58
115.00	-0.84
130.00	-0.75
145.00	-0.98
160.00	-0.76
175.00	-0.90
190.00	-0.82
200.00	-0.85



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-032-475-2

TRW-R

1100°C 1.00hr CYCLES 200.00hr TEST 2.339mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL. 90-8.25A.

HfO<sub>2</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

TRI(RUTILE).4(110)13.30A.

HfO<sub>2</sub>

Al<sub>2</sub>O<sub>3</sub>

NiO

100 hr

COLLECTED SPALL

TRI(RUTILE).4(110)13.30A.

SPINEL. 90-8.25A.

NiO

SPINEL. 90-8.10A.

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 90-8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

HfO<sub>2</sub>

NiO

200 hr

COLLECTED SPALL

NiO

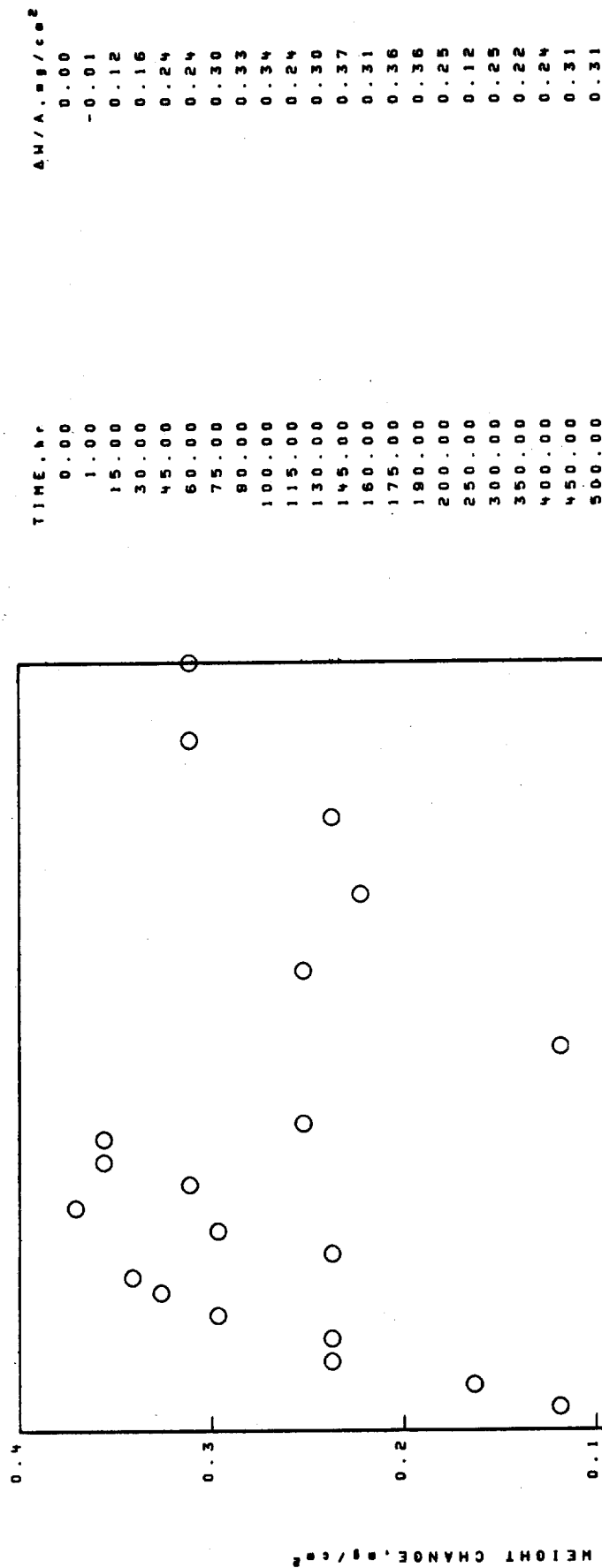
TRI(RUTILE).4(110)13.30A.

SPINEL. 90-8.10A.

SPINEL. 90-8.25A.

FACE CENTERED CUBIC MATRIX

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-032-471-5

TRW-R

1000°C 1.00hr CYCLES 500.00hr TEST 2.337mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

HfO<sub>2</sub>

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

SPINEL.  $a_0 = 0.10A$ .

HfO<sub>2</sub>

TRI(RUTILE).  $d(110) \leq 3.30A$ .

SPINEL.  $a_0 = 0.25A$ .

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $a_0 = 0.10A$ .

HfO<sub>2</sub>

TRI(RUTILE).  $d(110) \leq 3.30A$ .

FACE CENTERED CUBIC MATRIX

500 hr

500 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $a_0 = 0.10A$ .

TRI(RUTILE).  $d(110) \leq 3.30A$ .

HfO<sub>2</sub>

SPINEL.  $a_0 = 0.25A$ .

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX



02-04-049-658-5

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

N1 BASE

STATIC AIR

THICK 2.305mm TEST 100.00hr

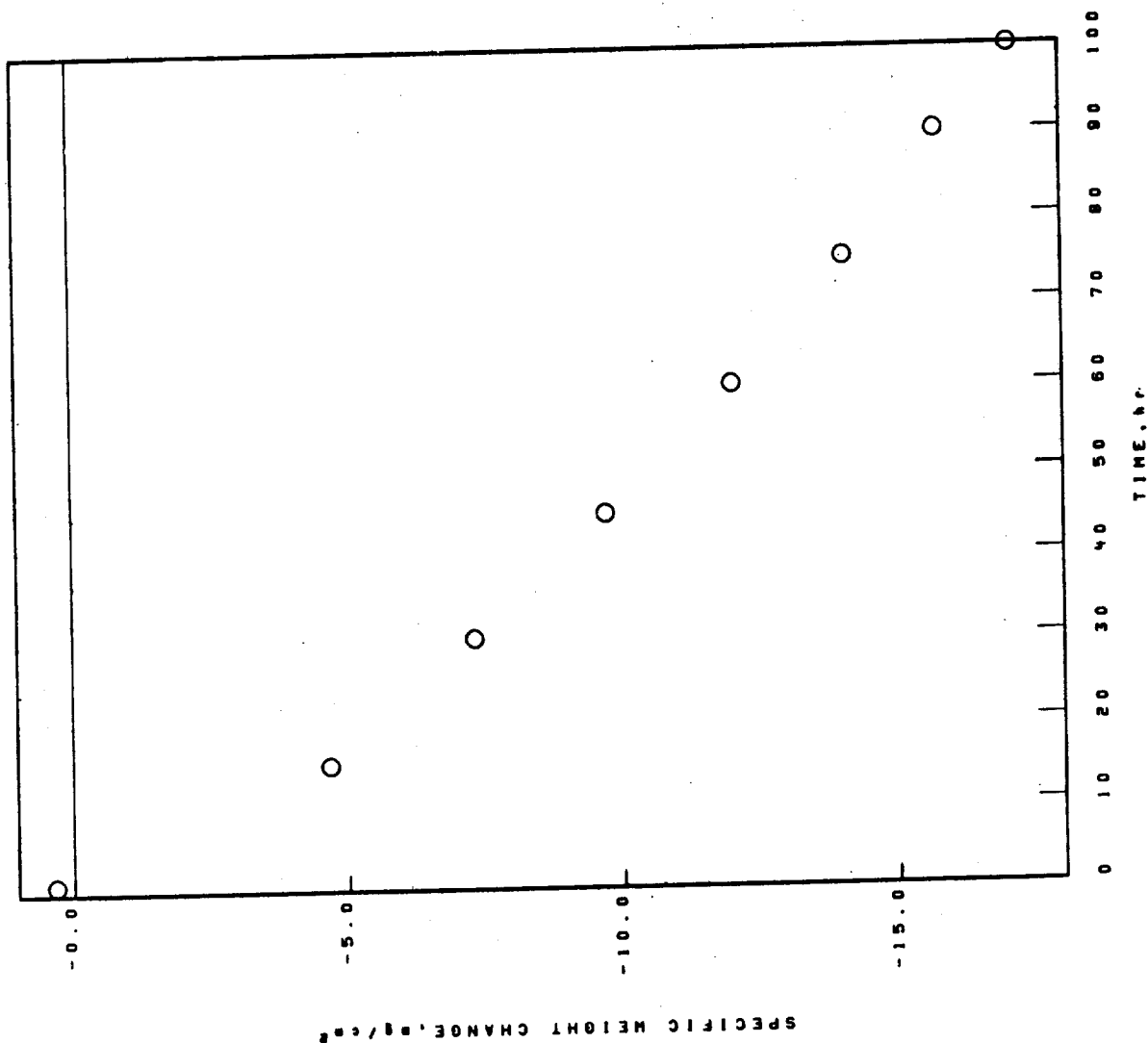
1150°C

1.00hr CYCLES

TRW-1800

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.32
15.00	-4.67
30.00	-7.31
45.00	-9.71
60.00	-12.02
75.00	-14.05
90.00	-15.73
100.00	-17.07



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-049-658-5  
 TRW-1800 1150°C 1.00hr CYCLES 100.00hr TEST 2.305mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

NiO

TRI(RUTILE).4(110)53.30A.

100 hr

STANDARD SURFACE

SPINEL. 80-8.10A.

Al<sub>2</sub>O<sub>3</sub>

Ni(W.Mo)O<sub>4</sub> TYPE I

NiO

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

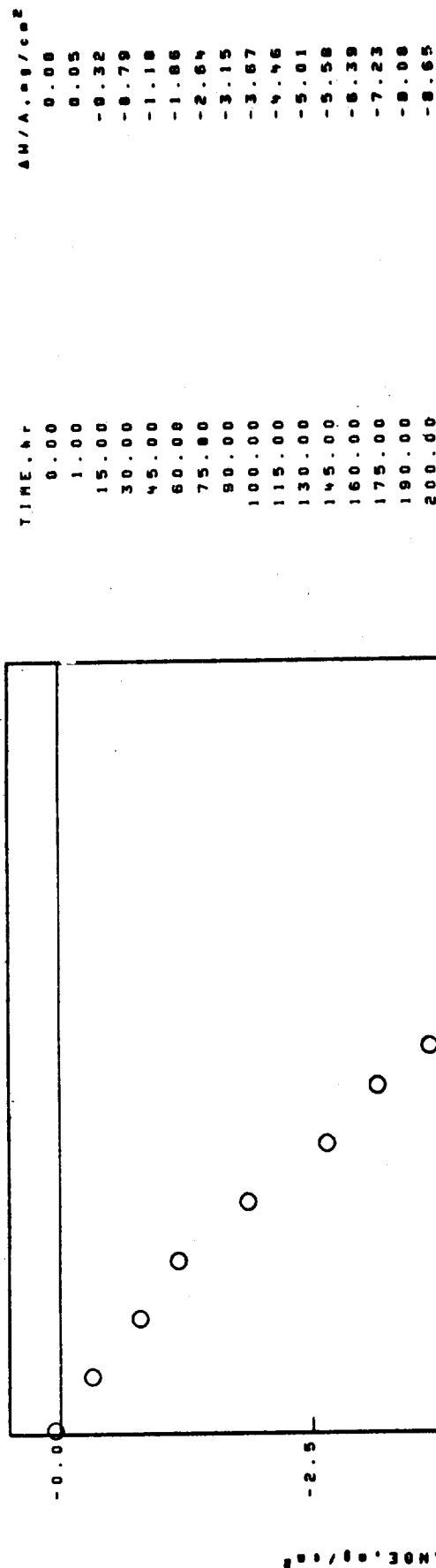
NiO

SPINEL. 80-8.20A.

Ni(W.Mo)O<sub>4</sub> TYPE I

SPINEL. 80-8.10A.

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-049-659-5

TRW-1800

1100°C 1.00hr CYCLES 200.00hr TEST 2.307mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Al<sub>2</sub>O<sub>3</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $a_0 = 8.10\text{\AA}$ .

100 hr

SECOND SURFACE PHASE

NiO

NiO

Ni(M.M.)O<sub>4</sub> TYPE I

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

SPINEL.  $a_0 = 8.35\text{\AA}$ .

FACE CENTERED CUBIC MATRIX

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL.  $a_0 = 8.10\text{\AA}$ .

Ni(M.M.)O<sub>4</sub> TYPE I

NiO

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

200 hr

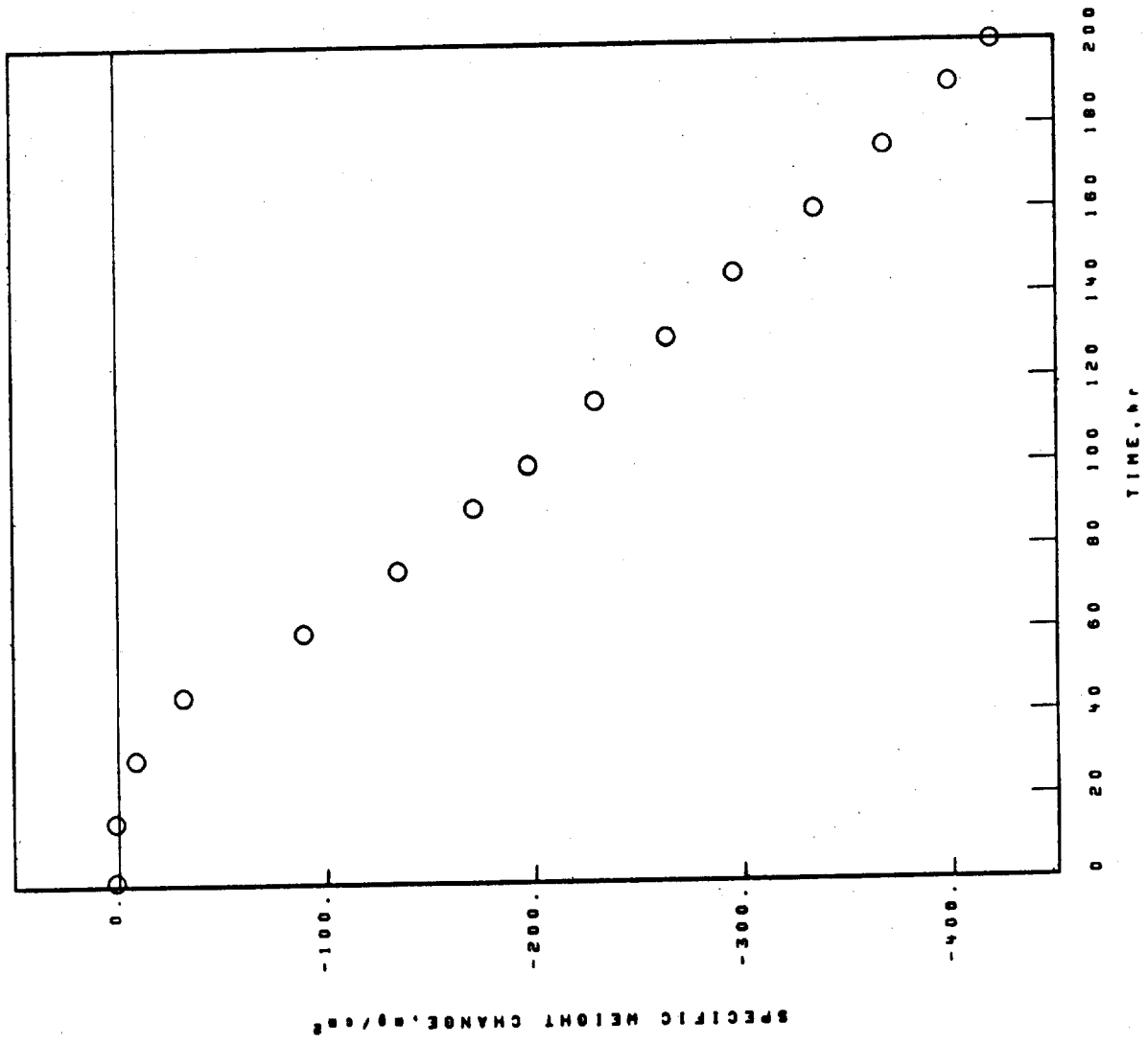
PROBABLE CROSS-SPALL

NiO

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-009-352-5  
 U-520 1150°C 1.00hr CYCLES 200.00hr TEST 2.239mm THICK STATIC AIR

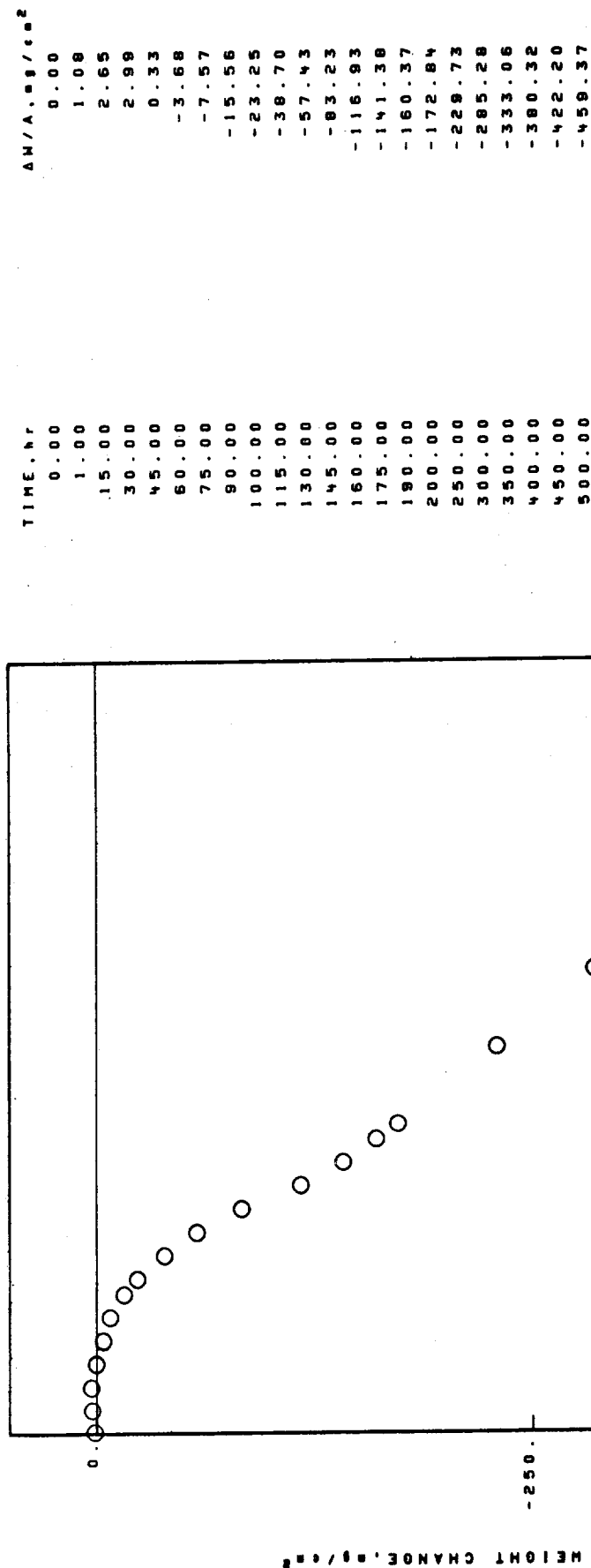
X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
NIO	SPINEL. $a_0=8.30\text{\AA}$ .
SPINEL. $a_0=8.30\text{\AA}$ .	NIO
Cr <sub>2</sub> O <sub>3</sub>	
NI(M,M+10), TYPE 2	

FACE CENTERED CUBIC MATRIX

NI BASE  
 U-520  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 500.00hr TEST 2.230mm THICK STATIC AIR  
 02-13-009-351-5

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS                      02-13-009-351-5  
 U-520                      1100°C                      1.00hr CYCLES                      500.00hr TEST                      2.230mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

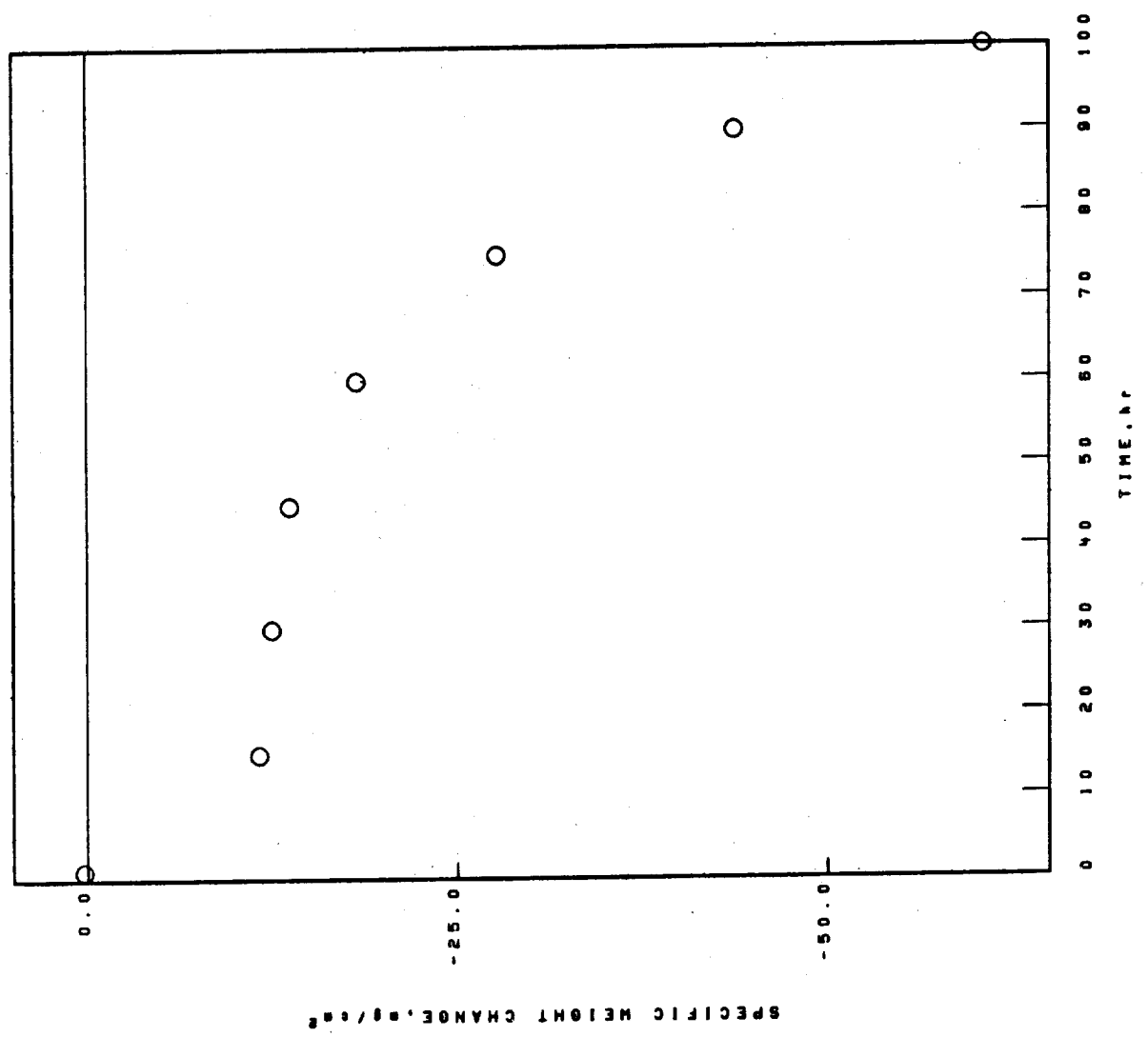
SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $a_0=8.30\text{\AA}$	NiO
NiO	SPINEL, $a_0=8.30\text{\AA}$
Cr <sub>2</sub> O <sub>3</sub>	Ni(Mn)O, TYPE 2
Ni(Mn)O, TYPE 2	Cr <sub>2</sub> O <sub>3</sub>
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES, $d$ VALUES
	2.01\AA
500 hr	500 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, $a_0=8.35\text{\AA}$	NiO
NiO	SPINEL, $a_0=8.30\text{\AA}$
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
FACE CENTERED CUBIC MATRIX	



NI BASE  
 U-700  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR  
 02-04 022-321-6

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔH/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.23
15.00	-11.64
30.00	-12.50
45.00	-13.72
60.90	-18.25
75.00	-27.74
90.00	-43.79
100.00	-60.56



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04 022-321-6  
 U-700 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta$ = 8.25A.	NiO
SPINEL. $\theta$ = 8.10A.	SPINEL. $\theta$ = 8.25A.
(Ni,Cr,F)TiO <sub>3</sub>	Ni(Mn)O, TYPE 2
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
Al <sub>2</sub> O <sub>3</sub>	
TRI(RUTILE). 4(110)53.30A.	

FACE CENTERED CUBIC MATRIX

STATIC AIR

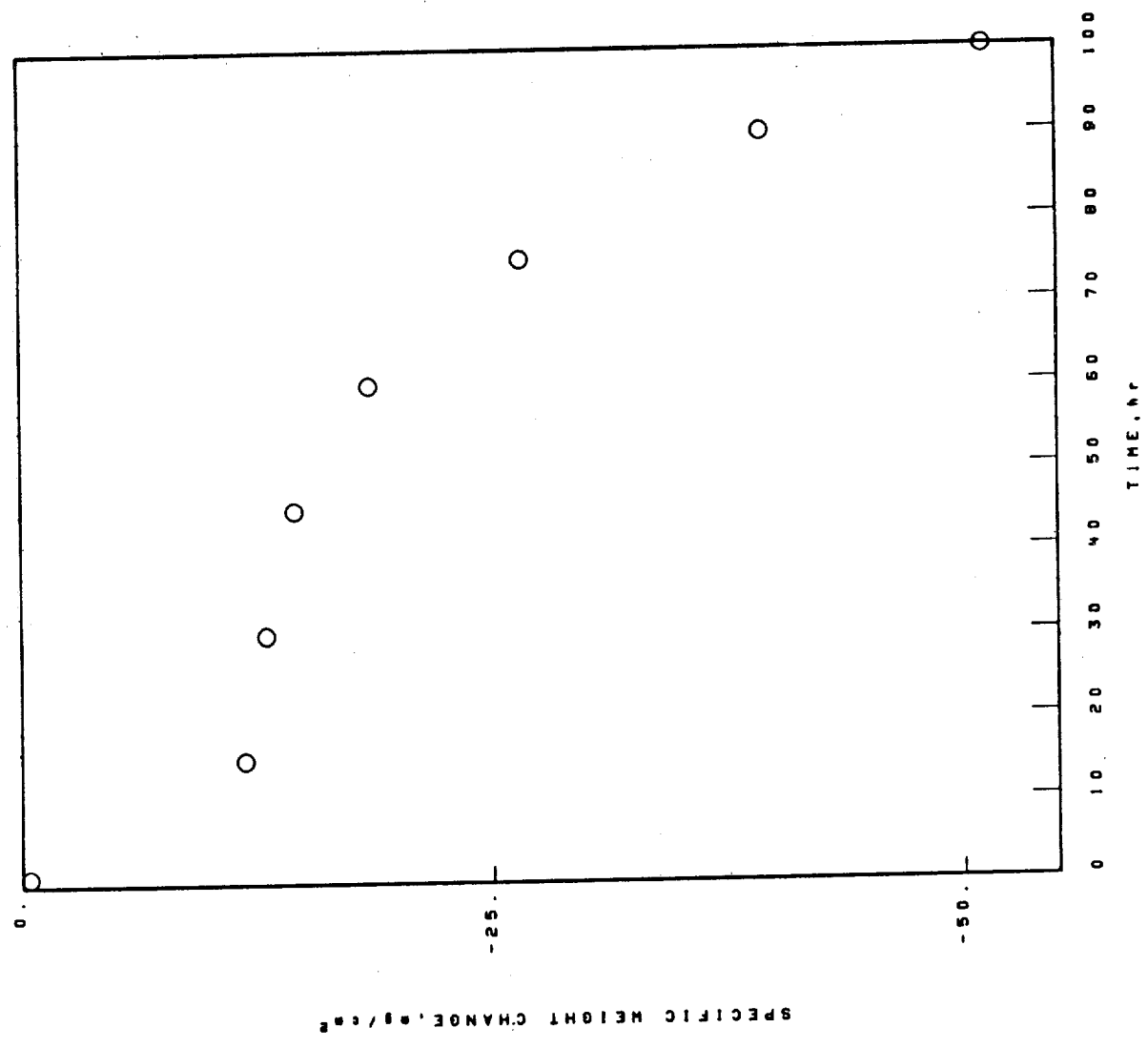
THICK 1.760mm

1150°C 1.00hr CYCLES 100.80hr TEST

U-700

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	-0.38
15.00	-11.84
30.00	-13.00
45.00	-14.53
60.00	-18.51
75.00	-26.57
90.00	-39.37
100.00	-51.14



M1 BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04 022-323-6  
 U-700 1150°C 1.00hr CYCLES 100.00hr TEST 1.760mm THICK STATIC AIR

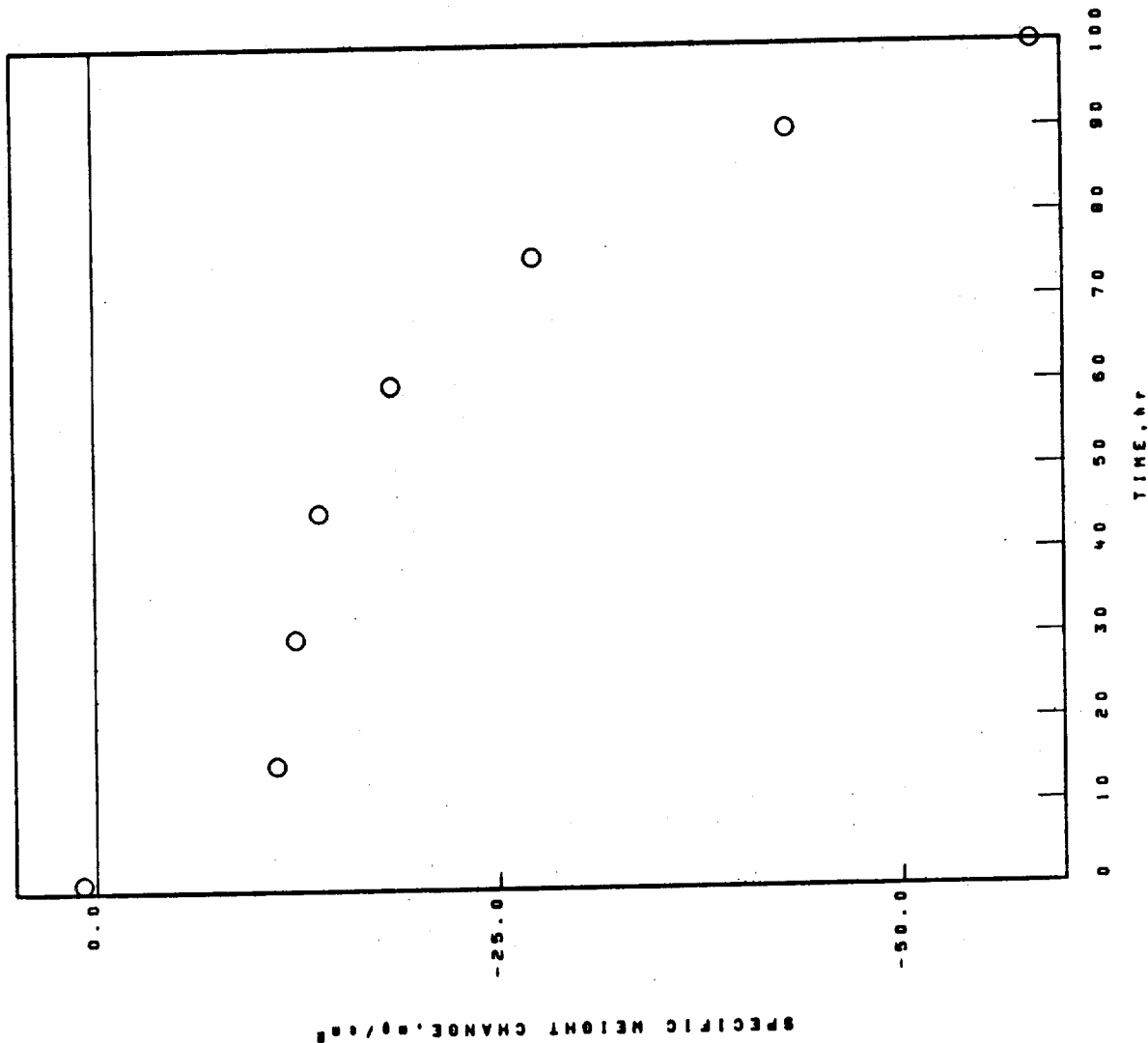
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta_0$ -8.30A.	NiO
SPINEL. $\theta_0$ -8.10A.	SPINEL. $\theta_0$ -8.30A.
NiO	
Cr <sub>2</sub> O <sub>3</sub>	
(Ni.Cr.Fe)TiO <sub>3</sub>	
Al <sub>2</sub> O <sub>3</sub>	
TRI(RUTILE).4(110)33.30A.	

FACE CENTERED CUBIC MATRIX

NI BASE      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS      02-04-043-438-1  
 U-700 CAST(SMP-1)      1150°C      1.00hr CYCLES      100.00hr TEST      2.314mm THICK      STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-438-1  
 U-700 CAST(SMP-1) 1150°C 1.00hr CYCLES 100.00hr TEST 2.314mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).d(110)53.30A.  
 100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL. a<sub>0</sub>=8.30A.  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL. a<sub>0</sub>=8.10A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Cr.Fe)TiO<sub>3</sub>  
 TRI(RUTILE).d(110)53.30A.

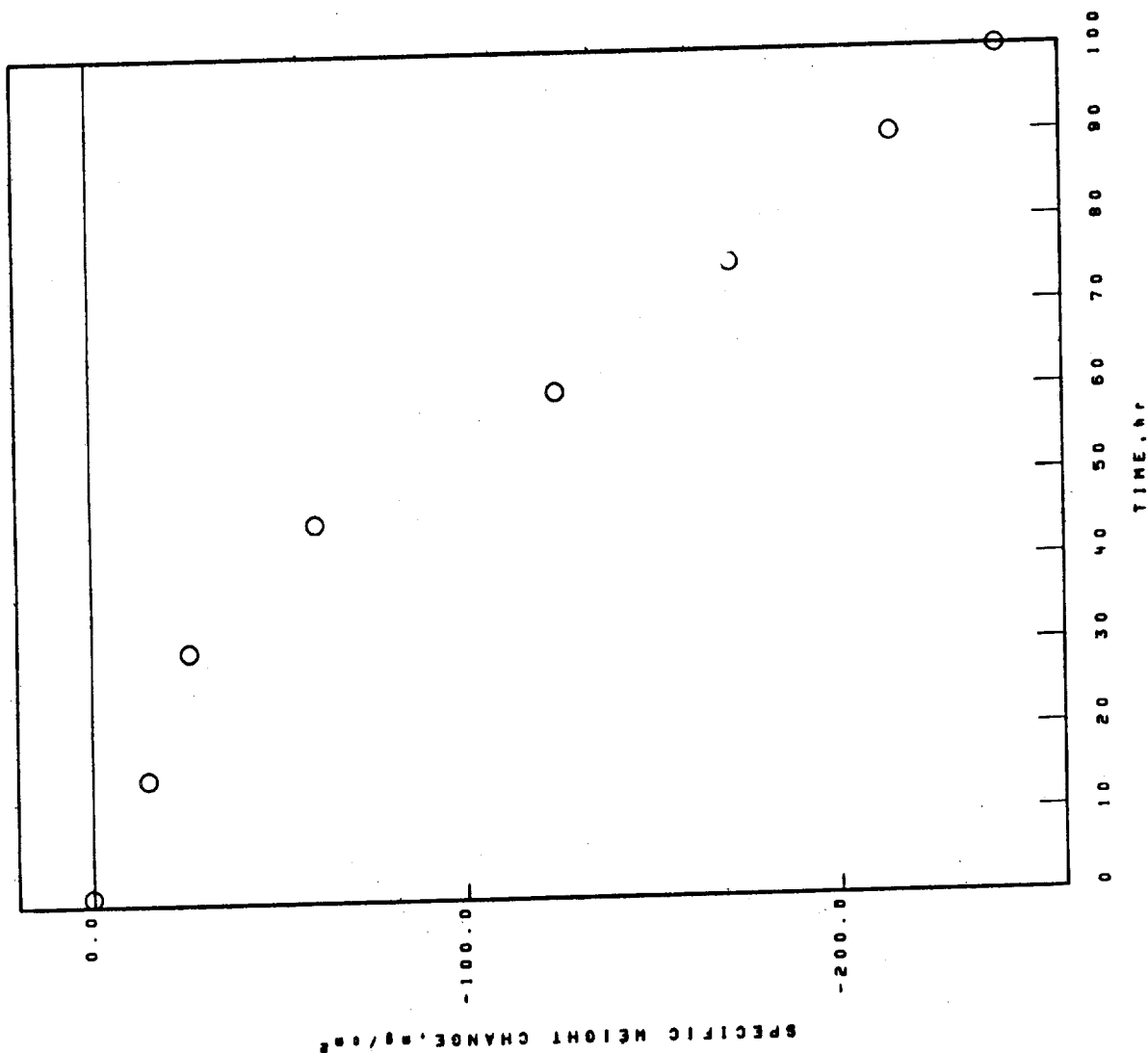
SPALL  
 1 hr  
 COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. a<sub>0</sub>=8.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Cr.Fe)TiO<sub>3</sub>  
 SPINEL. a<sub>0</sub>=8.10A.  
 TRI(RUTILE).d(110)53.30A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 COSAM U-700-17.0C  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.414mm THICK STATIC AIR  
 02-09-101-438-2

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔM/A, g/cm <sup>2</sup>
0.00	0.00
0.25	0.25
1.00	-14.79
15.00	-26.02
30.00	-60.21
45.00	-124.80
60.00	-171.59
75.00	-214.74
90.00	-243.21
100.00	



NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-101-438-2  
 COSAM U-700-17-00 1150°C 1.00hr CYCLES 100.00hr TEST 2.414mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
1 hr	1 hr
STANDARD SURFACE	COLLECTED SPALL
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
TRI(RUTILE).4(110)3.30A.	SPINEL. 00-0.30A.
TRI(RUTILE).4(110)3.30A.	TRI(RUTILE).4(110)3.30A.

UNKNOWN LINES. 4 VALUES  
 2.02A.  
 1.80A.

100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NiO	NiO
SPINEL. 00-0.30A.	SPINEL. 00-0.35A.
Cr <sub>2</sub> O <sub>3</sub>	
Ni(M.M.)O, TYPE 2	
SPINEL. 00-0.10A.	

FACE CENTERED CUBIC MATRIX



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

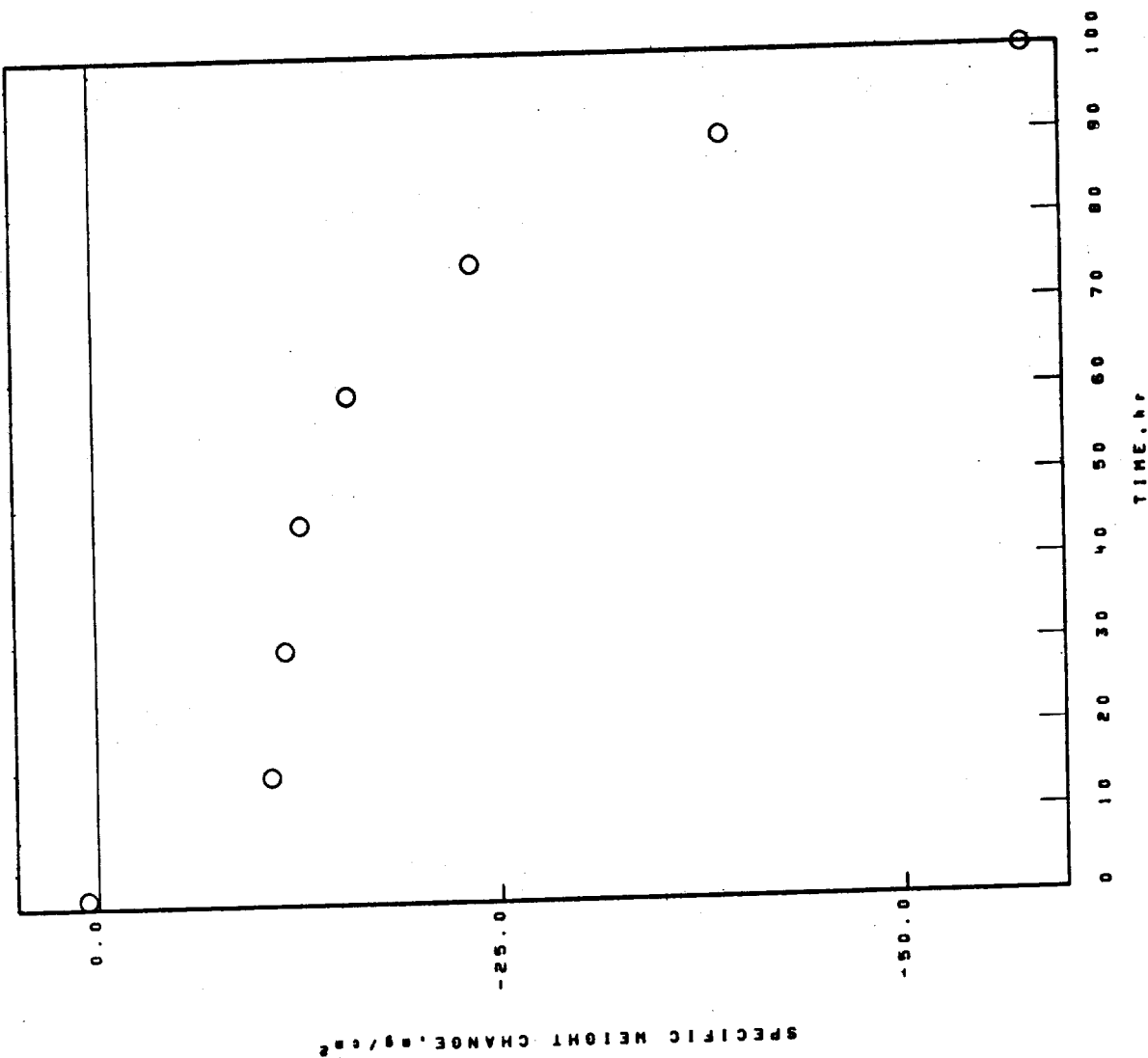
STATIC AIR

1150°C 1.00hr CYCLES 100.00hr TEST 2.306mm THICK

U-700 CAST(SMP-1)

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.65
15.00	-10.81
30.00	-11.74
45.00	-12.76
60.00	-15.77
75.00	-23.55
90.00	-38.05
100.00	-57.77



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-043-454-1

U-700 CAST(SMP-1)

1150°C 1.00hr CYCLES 100.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53-30A.

SPINEL. 90-8-30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL. 90-8-25A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

SPINEL. 90-8-18A.

Ni(M.Ni)O, TYPE 2

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8-35A.

TRI(RUTILE).4(110)53-30A.

100 hr

COLLECTED SPALL

NiO

SPINEL. 90-8-25A.

SPINEL. 90-8-18A.

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

TEST 2.309

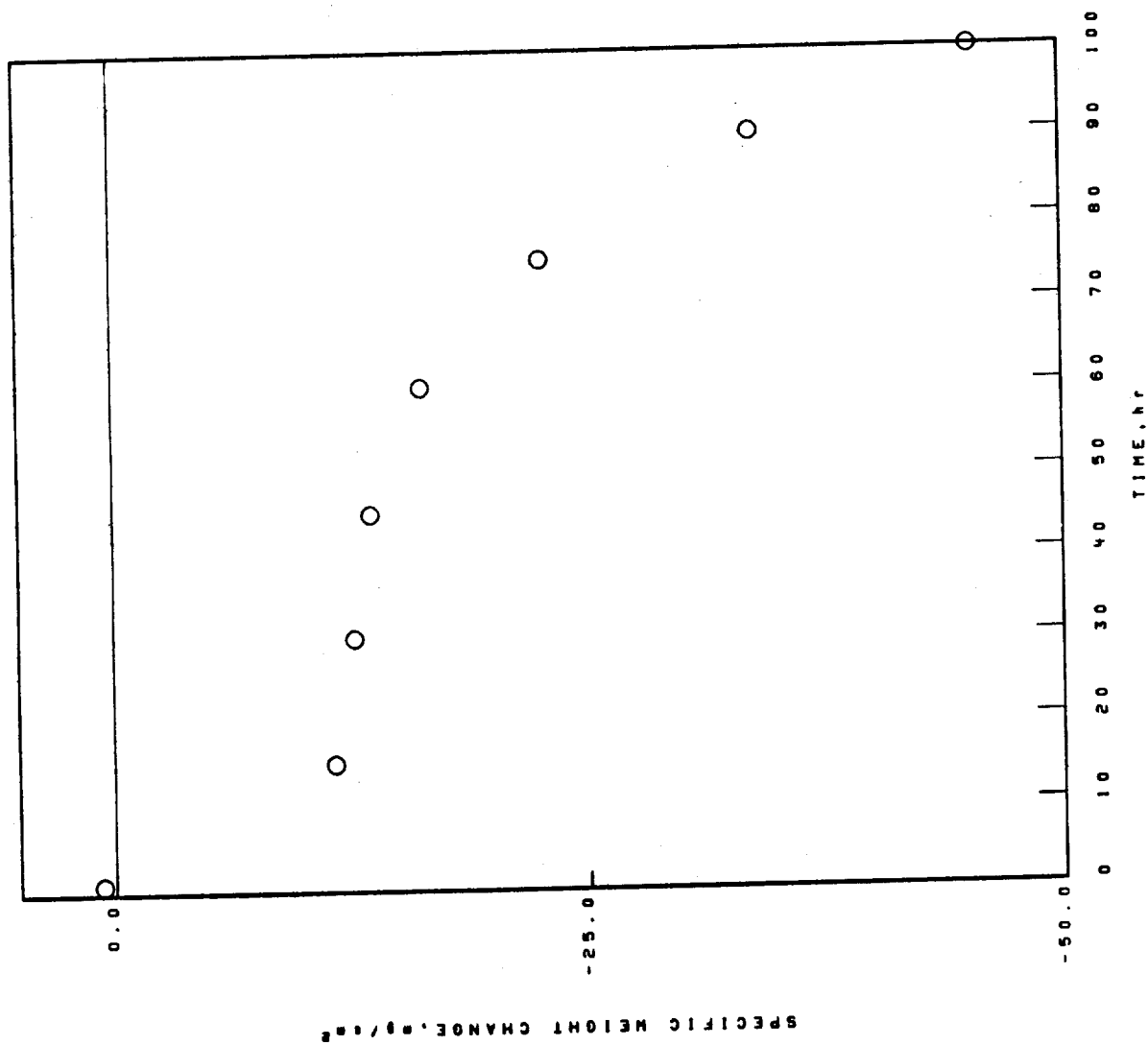
1.00hr CYCLES

1150°C

U-700

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.64
15.00	-11.63
30.00	-12.70
45.00	-13.59
60.00	-16.31
75.00	-22.66
90.00	-33.73
100.00	-45.27



NI BASE  
 U-700  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.309mm THICK  
 STATIC AIR  
 02-04-022-470-5

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPALL  
 1 hr  
 COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 8-8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL. 8-8.30A.  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 NiO

FACE CENTERED CUBIC MATRIX

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 8-8.30A.  
 Cr<sub>2</sub>O<sub>3</sub>

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

N1 BASE

STATIC AIR

THICK

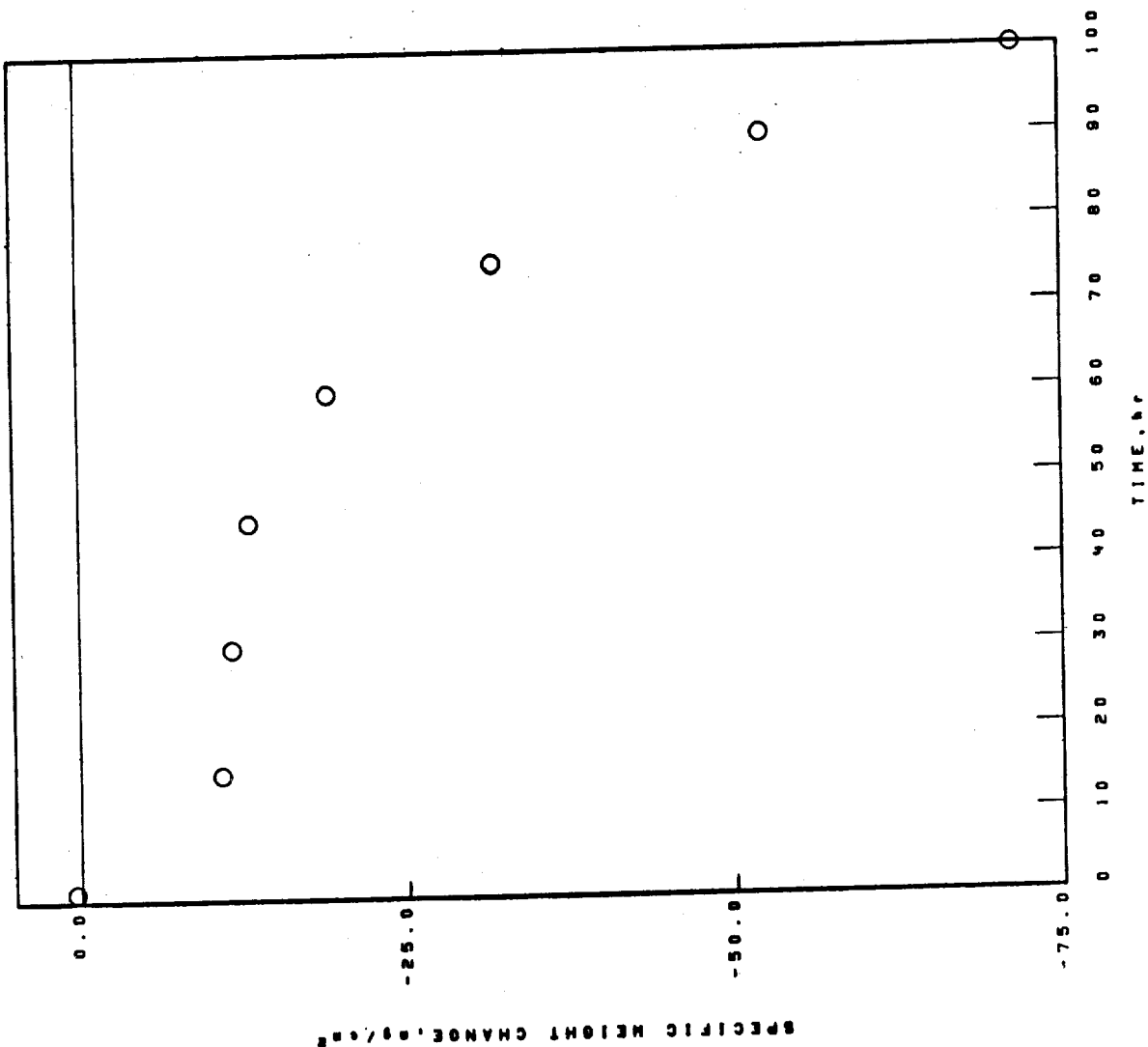
TEST 2.309

100.00hr

1150°C 1.00hr CYCLES

U-700

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.42
15.00	-10.79
30.00	-11.65
45.00	-13.02
60.00	-19.00
75.00	-31.00
90.00	-52.30
100.00	-71.45

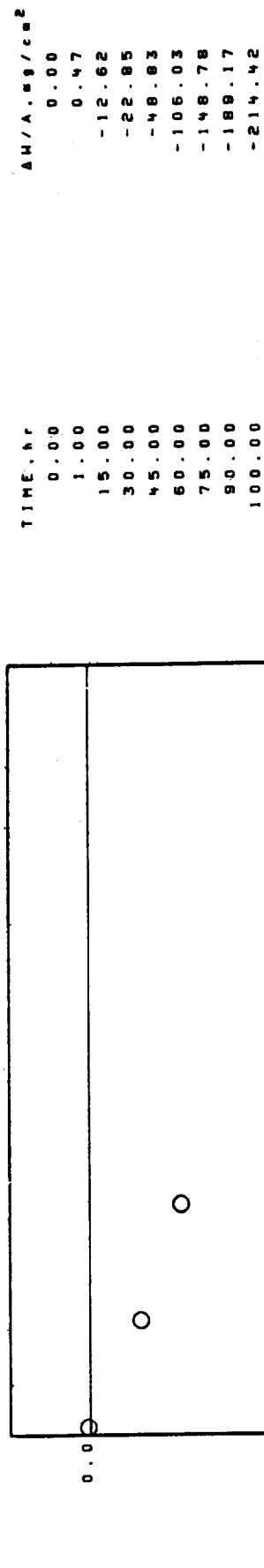
NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-022-476-6  
 U-700 1150°C 1.00hr CYCLES 100.00hr TEST 2.309mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE 1 hr STANDARD SURFACE $Cr_2O_3$ TRI(RUTILE).4(110)53.30A.	SPALL 1 hr COLLECTED SPALL $Cr_2O_3$ SPINEL. $\theta_0=8.25A$ .
FACE CENTERED CUBIC MATRIX 100 hr STANDARD SURFACE $NiO$ SPINEL. $\theta_0=8.30A$ . $Cr_2O_3$ FACE CENTERED CUBIC MATRIX	100 hr COLLECTED SPALL $NiO$ SPINEL. $\theta_0=8.30A$ . $Cr_2O_3$ (NI.Cr.Fe)TiO <sub>3</sub> TRI(RUTILE).4(110)53.30A.

NI BASE      EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS      02-09-101-654-5  
 COSAM U-700-17.0C      1150°C      1.00hr CYCLES      100.00hr TEST      2.273mm THICK      STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-101-654-5  
 COSAM U-700-17.0C° 1150°C 1.00hr CYCLES 100.08hr TEST 2.273mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL  
 1 hr  
 STANDARD SURFACE COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPINEL. 80-8.25A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE COLLECTED SPALL  
 NiO  
 SPINEL. 80-8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(W,Mn)O, TYPE 2  
 SPINEL. 80-8.10A.

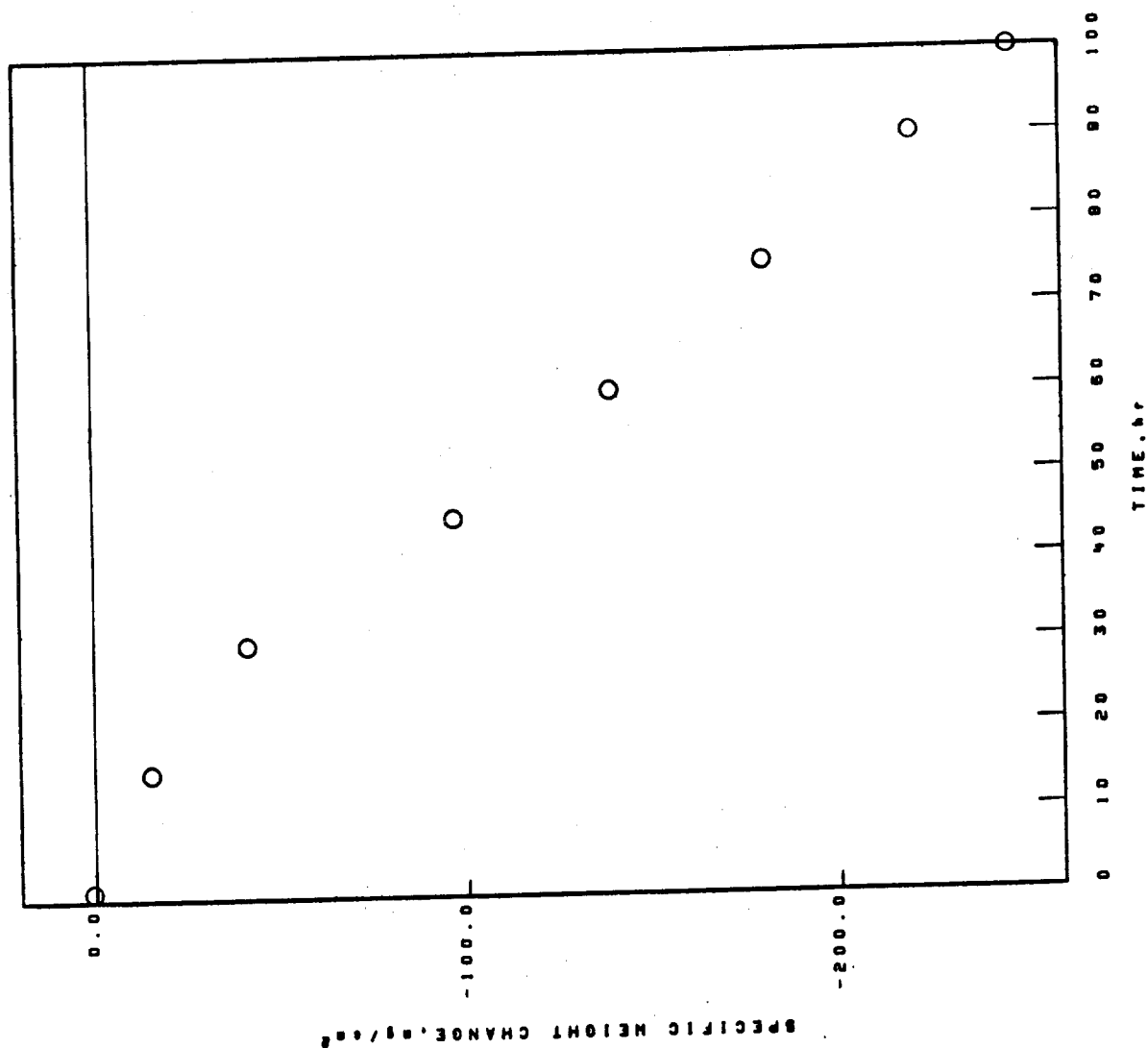
FACE CENTERED CUBIC MATRIX



NI BASE  
 M-55 (UDIMET-700)  
 EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.206mm THICK STATIC AIR  
 02-09-081-654-6

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.71
15.00	-15.07
30.00	-41.08
45.00	-96.83
60.00	-139.08
75.00	-180.40
90.00	-218.97
100.00	-246.47



NI BASE  
 EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS  
 M-55(UDIMET-700)  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.286mm THICK  
 02-09-081-654-6  
 STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL. 80-8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(W.M.)O<sub>4</sub> TYPE 2  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 80-8.25A.  
 Ni(W.M.)O<sub>4</sub> TYPE 2

FACE CENTERED CUBIC MATRIX

02-13-017-654-4

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

NI BASE

U-700(R.M.)

STATIC AIR

THICK 2.215mm

TEST

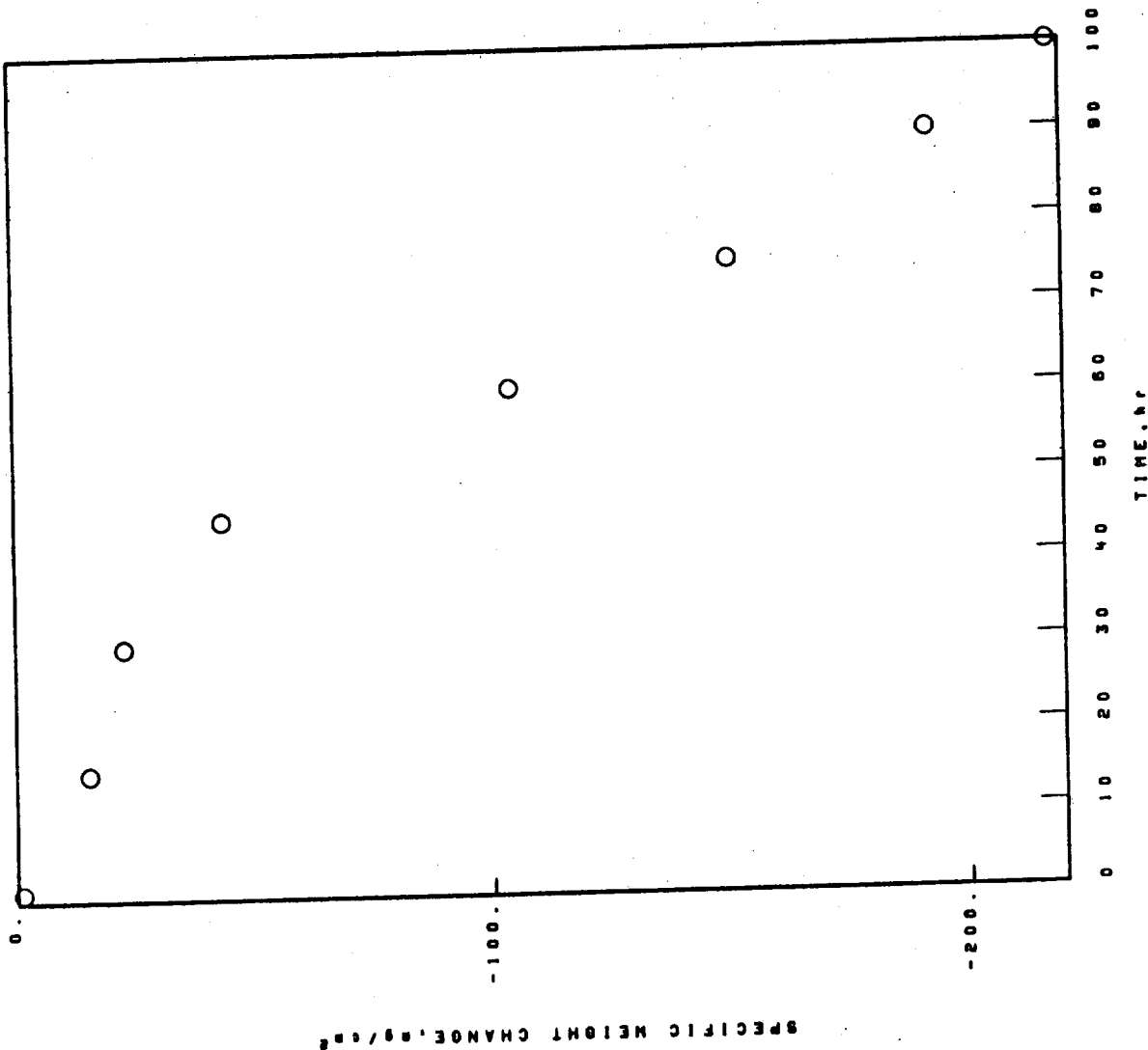
100.00hr

1.00hr CYCLES

1150°C

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	-1.06
15.00	-15.30
30.00	-22.77
45.00	-43.55
60.00	-104.14
75.00	-150.14
90.00	-192.02
100.00	-217.54



NI BASE  
 U-700(R.M.)  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1150°C 1.00hr CYCLES 100.00hr TEST 2.215mm THICK STATIC AIR  
 02-13-017-654-4

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPINEL. 40-B.25A.  
 SPALL  
 1 hr  
 COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL. 40-B.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(M.M.)O, TYPE 2  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 40-B.25A.  
 Ni(M.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST 1.762

200.00hr

1100°C

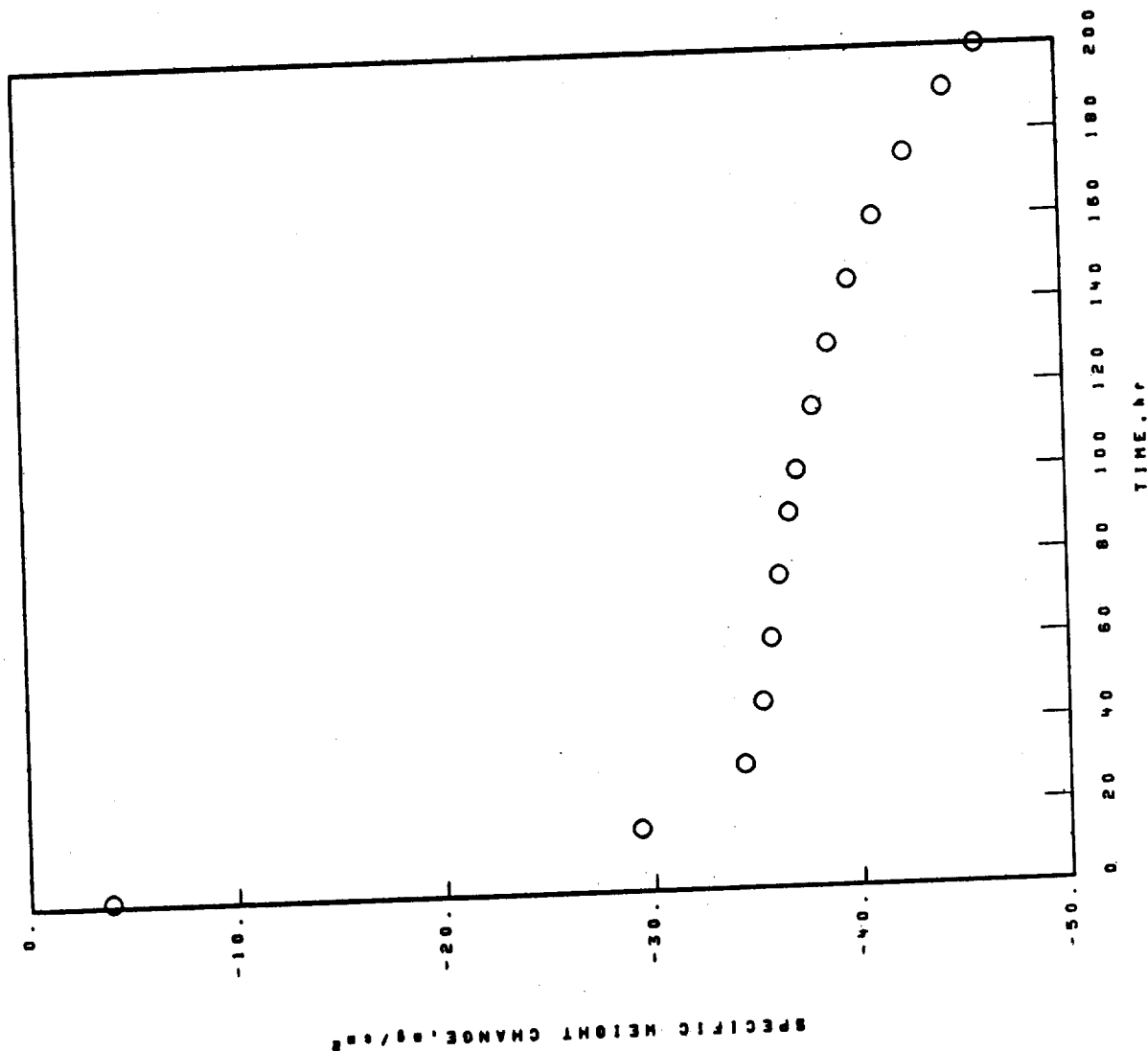
1.00hr

CYCLES

U-700

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	-3.89
15.00	-29.37
30.00	-34.38
45.00	-35.31
60.00	-35.78
75.00	-36.23
90.00	-36.76
100.00	-37.17
115.00	-38.00
130.00	-38.79
145.00	-39.03
160.00	-41.08
175.00	-42.65
190.00	-44.58
200.00	-46.18



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

U-700

02-04 022-310-8

1100°C

1.00hr CYCLES

200.00hr TEST

1.762mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

SPINEL.  $\theta_0 = 8.10^\circ$ .

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).  $\theta_0(110) \leq 3.30^\circ$ .

FACE CENTERED CUBIC MATRIX

SCALE

200 hr

COLLECTED SPALL

NIO

SPINEL.  $\theta_0 = 8.25^\circ$ .

UNKNOWN LINES.  $\theta$  VALUES

3.09A.

2.44A.

02-04 022-324-6

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

2.308mm

TEST

200.00hr

CYCLES

1.00hr

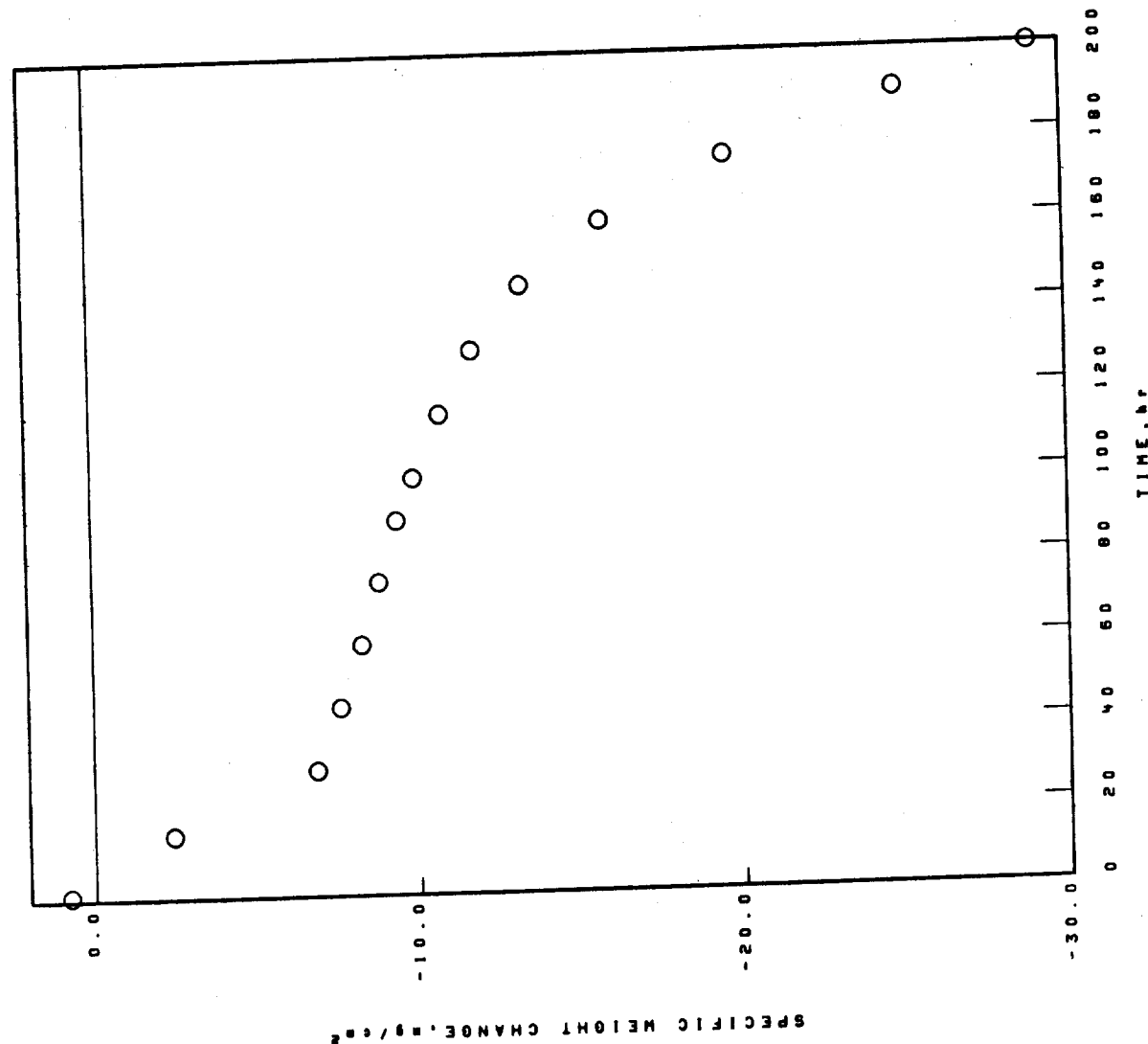
1100°C

N1 BASE

U-700

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.77
15.00	-2.42
30.00	-6.86
45.00	-7.61
60.00	-8.28
75.00	-8.84
90.00	-9.42
100.00	-9.95
115.00	-10.77
130.00	-11.79
145.00	-13.32
160.00	-15.03
175.00	-18.67
190.00	-24.92
200.00	-29.06



NI BASE  
 U-700  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 02-04 022-324-6

1100°C 1.00hr CYCLES 200.00hr TEST 2.308mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 200 hr  
 STANDARD SURFACE  
 SPINEL, 90-8.18A.  
 NiO  
 SPINEL, 90-8.25A.  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRIRUTILE, 4(110)13.39A.

SPALL  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL, 90-8.38A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES. 4 VALUES  
 3.10A.



02-04 022-326-B

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

U-700

STATIC AIR

THICK

TEST

200.00hr

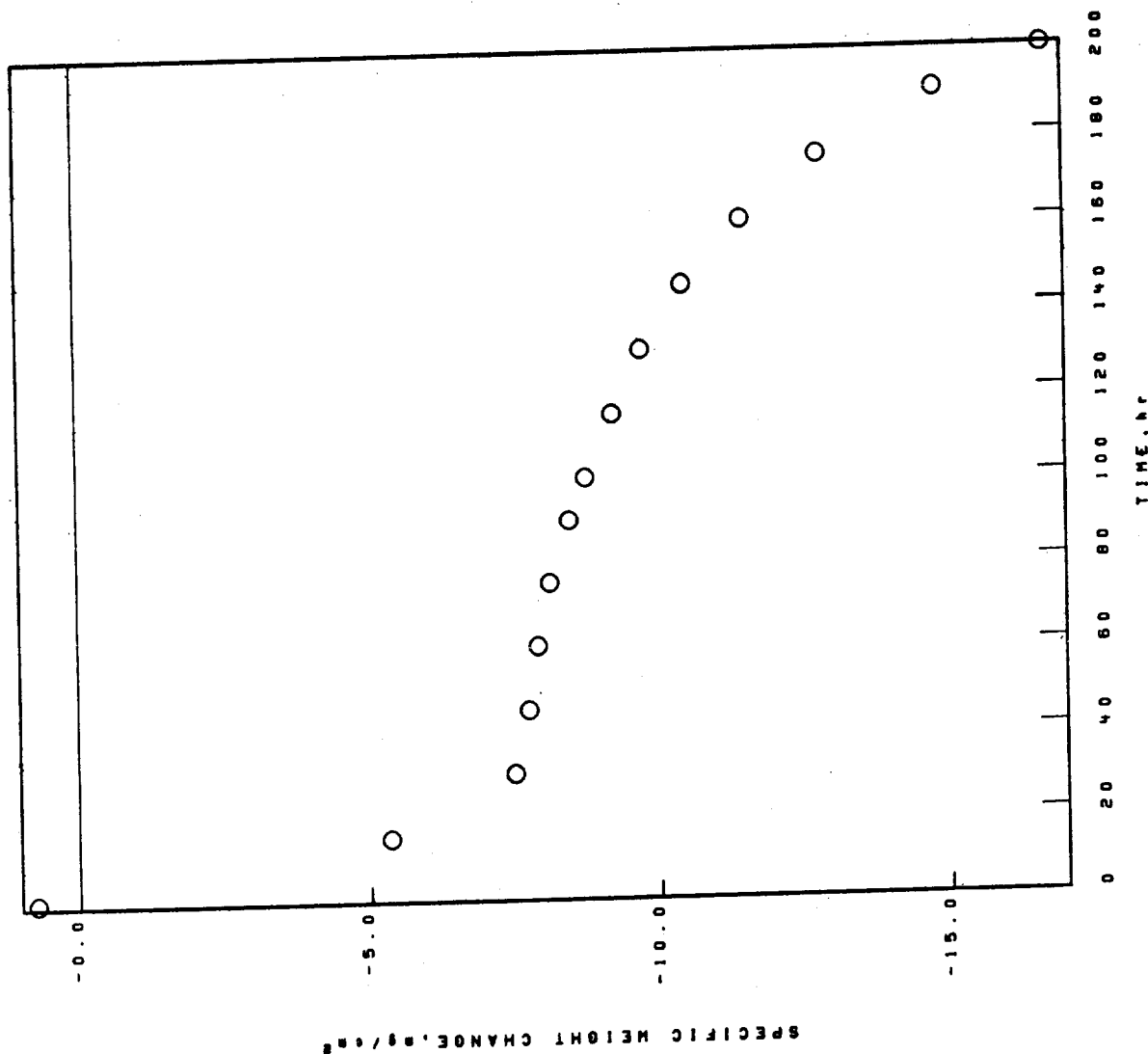
1.00hr CYCLES

1100°C

1.748mm

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.73
15.00	-5.35
30.00	-7.50
45.00	-7.75
60.00	-7.92
75.00	-8.14
90.00	-8.48
100.00	-8.76
115.00	-9.24
130.00	-9.73
145.00	-10.45
160.00	-11.47
175.00	-12.80
190.00	-14.80
200.00	-16.65



°

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04 022-326-6  
U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.748mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
200 hr

STANDARD SURFACE  
SPINEL. 20-8.15A.  
SPINEL. 20-8.30A.  
(Ni.Co.Fe)TiO<sub>3</sub>  
Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).4(110)53.30A.  
Al<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

200 hr  
COLLECTED SPALL  
SPINEL. 20-8.30A.  
NiO  
NiW.Mn)O<sub>3</sub> TYPE 1  
TRI(RUTILE).4(110)53.30A.  
(Ni.Co.Fe)TiO<sub>3</sub>  
Cr<sub>2</sub>O<sub>3</sub>

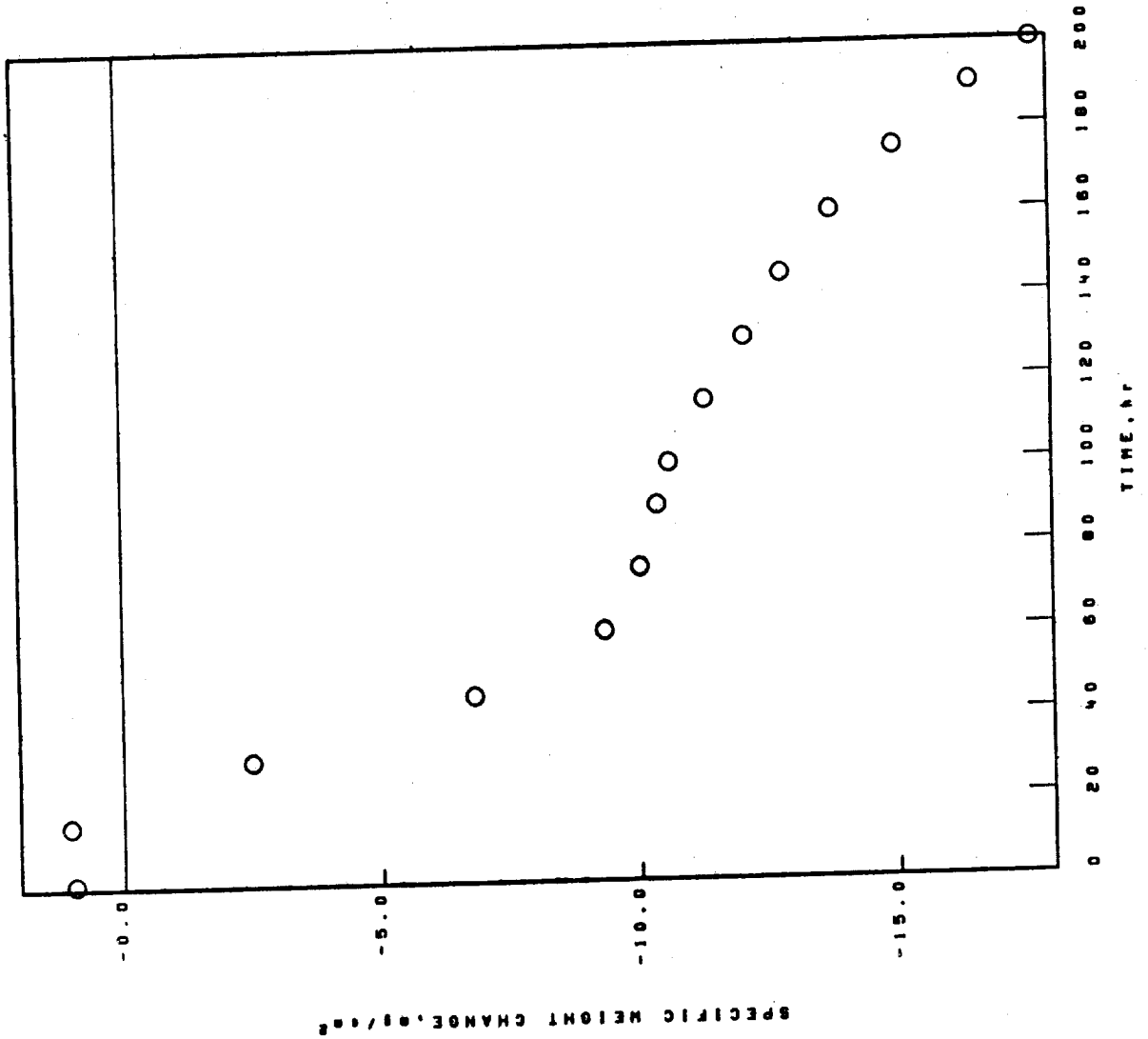
NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

U-700 CAST(SMP-1)

1100°C 1.00hr CYCLES 200.00hr TEST 2.310mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.95
15.00	1.02
30.00	-2.50
45.00	-6.81
60.00	-8.34
75.00	-10.04
90.00	-10.38
100.00	-10.61
115.00	-11.31
130.00	-12.08
145.00	-12.82
160.00	-13.78
175.00	-15.02
180.00	-16.51
200.00	-17.69



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-043-437-1  
 U-700 CAST(SMP-1)                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2.310mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

100 hr

STANDARD SURFACE

SPINEL. 20-8.10A.

NiO

(Ni.Co.Fe)TiO<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL. 20-8.10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

PROBABLE CROSS-SPALL

SPINEL. 20-8.30A.

NiO

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

200 hr

PROBABLE CROSS-SPALL

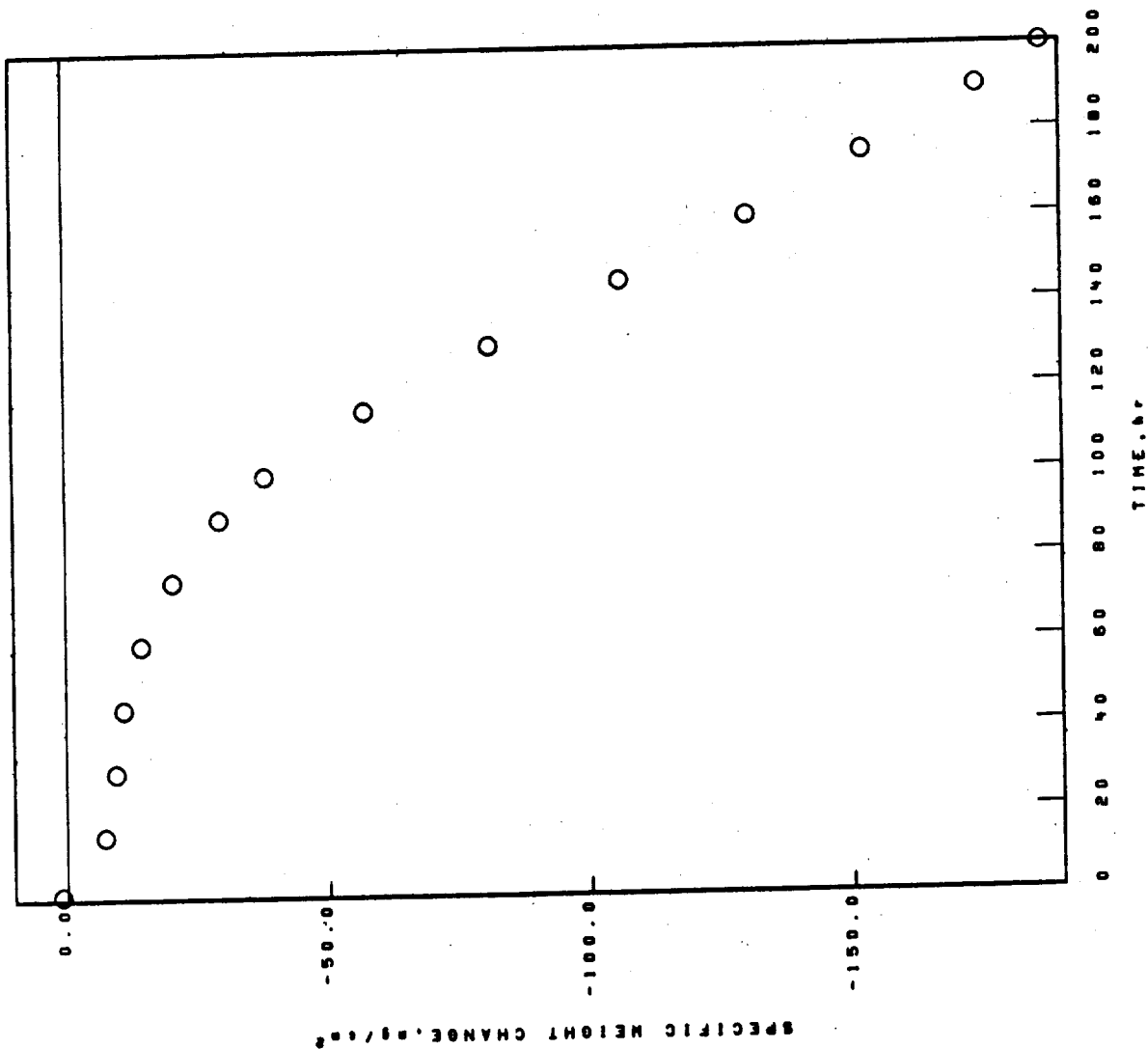
NiO

SPINEL. 20-8.35A.

Cr<sub>2</sub>O<sub>3</sub>

NI BASE  
 COSAM U-700-17.0C  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.414mm THICK  
 STATIC AIR  
 02-09-101-437-2

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔH/ΔA, g/cm²
0.00	0.00
1.00	0.99
15.00	-7.22
30.00	-9.41
45.00	-10.97
60.00	-14.39
75.00	-20.45
90.00	-29.33
100.00	-39.13
115.00	-57.19
130.00	-81.11
145.00	-106.04
160.00	-130.30
175.00	-152.38
190.00	-174.14
200.00	-188.38

W1 BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-101-437-2

COSAM U-700-17.0C°

1100°C 1.00hr CYCLES 200.00hr TEST 2.414mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.30A.

NiO

(Ni.Co.Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta_0$ -8.35A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

SPINEL.  $\theta_0$ -8.30A.

NiO

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

200 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.35A.

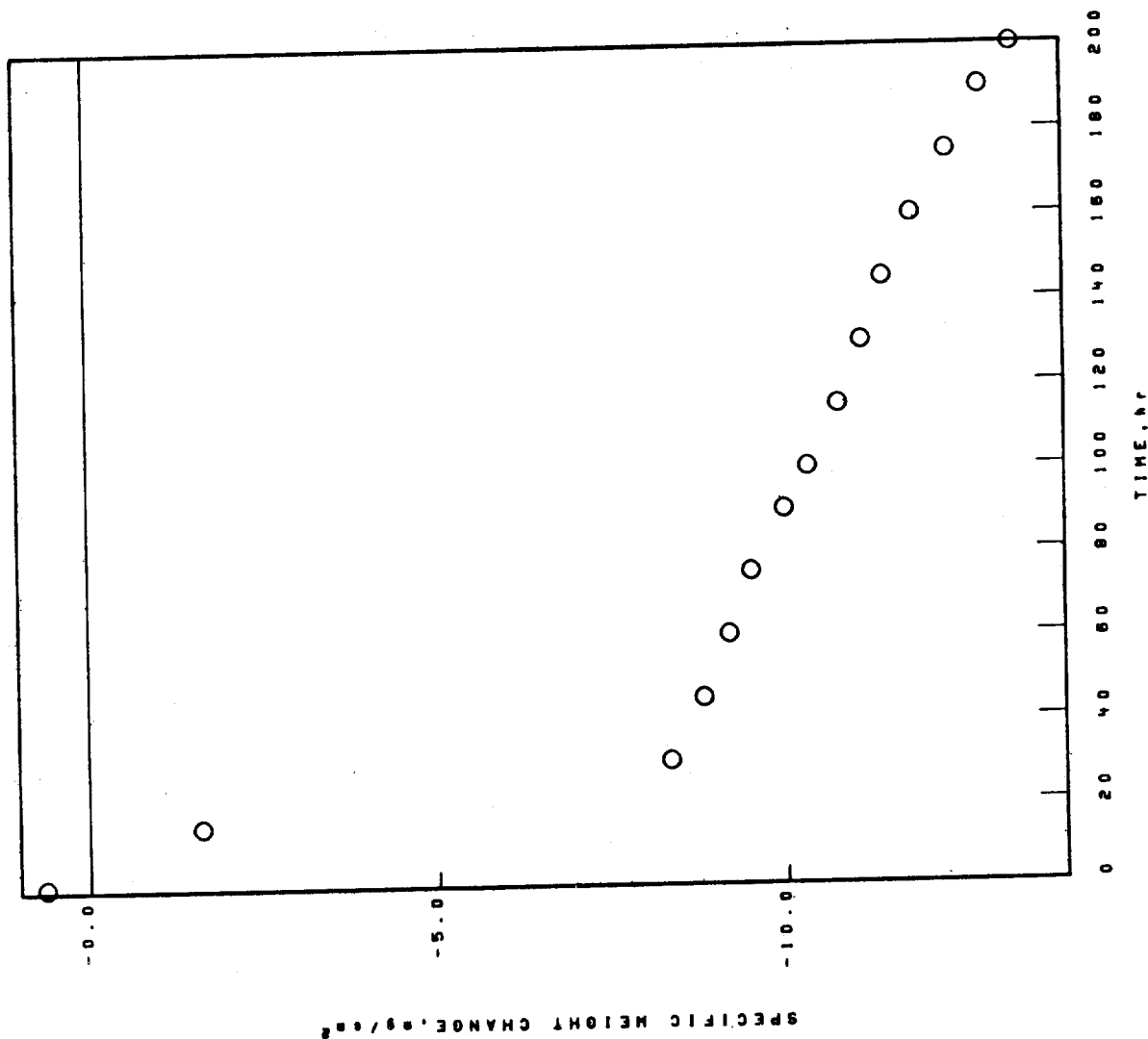
Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

NI BASE  
 U-700 CAST(SMP-1)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR  
 02-04-043-453-1

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{g/cm}^2$
0.00	0.00
1.00	0.63
15.00	-1.61
30.00	-8.34
45.00	-8.82
60.00	-8.19
75.00	-9.52
90.00	-10.00
100.00	-10.34
115.00	-10.77
130.00	-11.11
145.00	-11.42
160.00	-11.84
175.00	-12.35
190.00	-12.83
200.00	-13.28



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-453-1  
 U-700 CAST(SMP-1) 1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPINEL. 90-8.25A.

SPALL  
 1 hr  
 COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 NiO

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL. 90-8.10A.  
 NiO  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Ce,F)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 90-8.30A.  
 (Ni,Ce,F)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL. 90-8.05A.  
 TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 SPINEL. 90-8.10A.  
 Al<sub>2</sub>O<sub>3</sub>  
 (Ni,Ce,F)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

200 hr  
 COLLECTED SPALL  
 NiO  
 (Ni,Ce,F)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL. 90-8.30A.  
 SPINEL. 90-8.10A.

FACE CENTERED CUBIC MATRIX



02-04-022-469-5

# COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

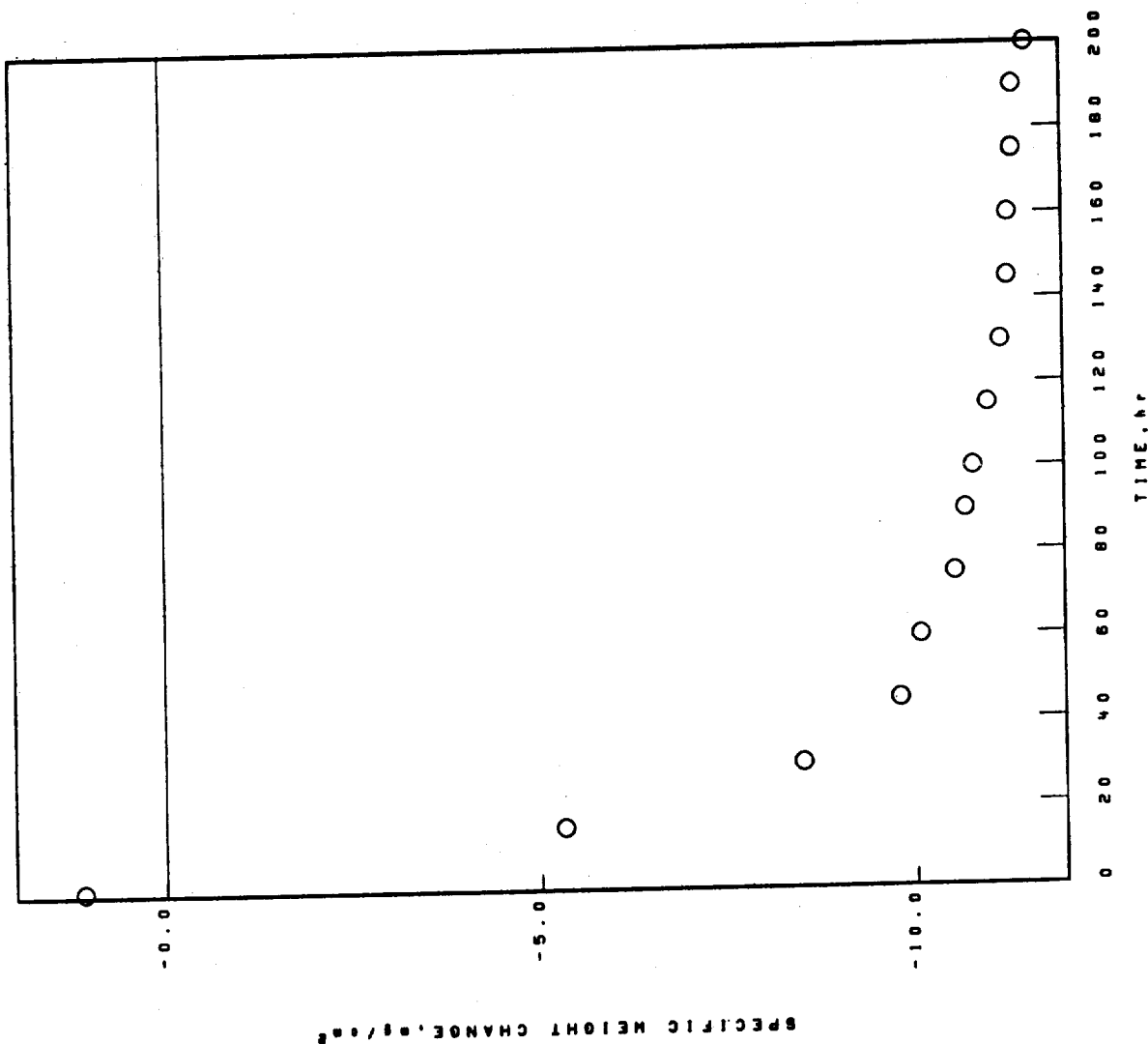
THICK 2.312mm

TEST 200.00hr

1100°C 1.00hr CYCLES

U-700

## SPECIFIC WEIGHT CHANGE DATA



Ni BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-022-469-5

U-700

1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.

Al<sub>2</sub>O<sub>3</sub>

NiO

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.

Al<sub>2</sub>O<sub>3</sub>

NiO

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

COLLECTED SPALL

TRI(RUTILE).4(110)>3.30A.

Cr<sub>2</sub>O<sub>3</sub>

NiO

100 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.30A.

200 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta_0$ -8.25A.

TRI(RUTILE).4(110)>3.30A.

02-04-022-477-6

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

U-700

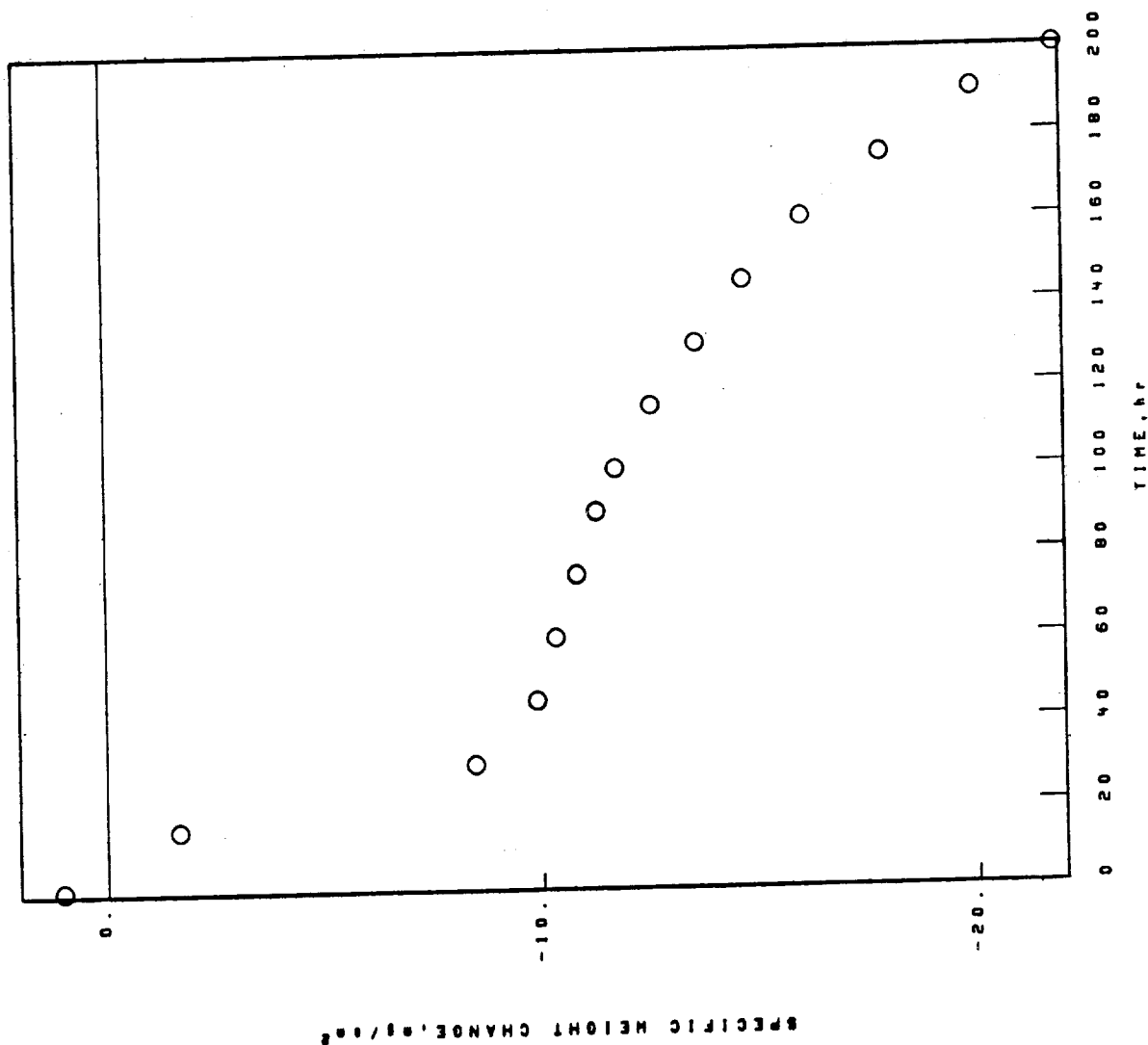
STATIC AIR

THICK 2.320mm TEST 200.00hr

1100°C 1.00hr CYCLES

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	1.02
15.00	-1.65
30.00	-8.46
45.00	-9.90
60.00	-10.34
75.00	-10.84
90.00	-11.28
100.00	-11.73
115.00	-12.56
130.00	-13.60
145.00	-14.69
160.00	-16.05
175.00	-17.88
190.00	-19.98
200.00	-21.86



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-022-477-6

U-700

1100°C 1.00hr CYCLES 200.00hr TEST 2.320mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL. 00-8-25A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

COLLECTED SPALL

SPINEL. 00-8-10A.

WIO

Al<sub>2</sub>O<sub>3</sub>

SPINEL. 00-8-25A.

SPINEL. 00-8-10A.

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

COLLECTED SPALL

SPINEL. 00-8-10A.

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

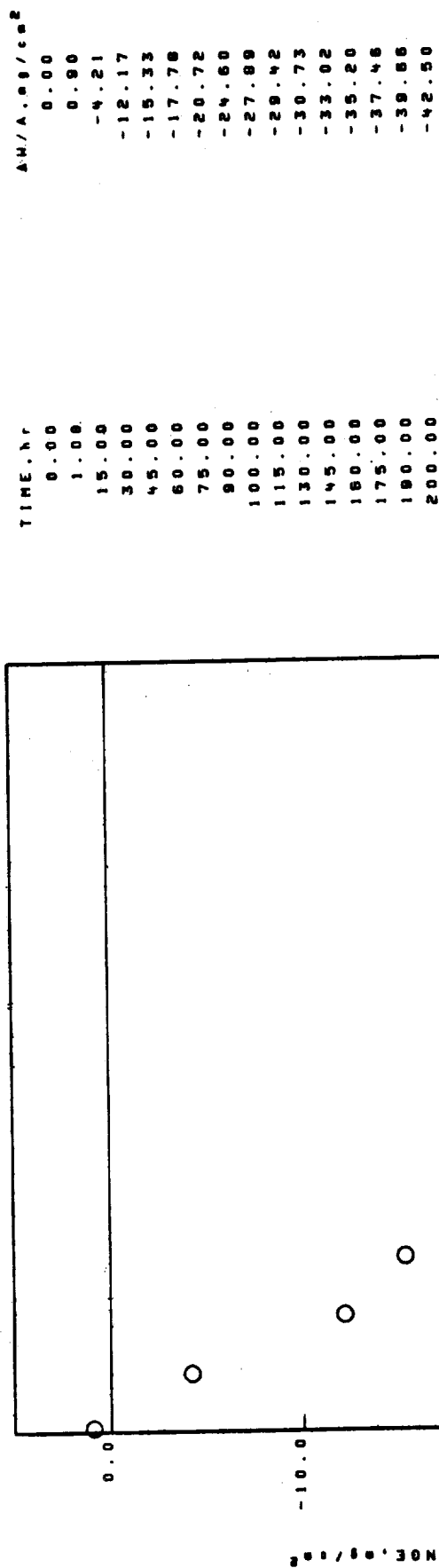
(MT.Co.F.)TiO<sub>2</sub>

SPINEL. 00-8-25A.

FACE CENTERED CUBIC MATRIX

NI BASE      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS      02-04-043-610-1  
 U-700 CAST(SMP-1)      1100°C      1.00MP CYCLES      200.00MP TEST      2.312mm THICK      STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-610-1  
 U-700 CAST(SMP-1) 1100°C 1.00hr CYCLES 200.00hr TEST 2.312mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 $\text{Cr}_2\text{O}_3$   
 TRI(RUTILE).4(110)53.30A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.10A.$   
 $\text{Al}_2\text{O}_3$   
 $\text{NiO}$   
 $(\text{Ni},\text{Co},\text{Fe})\text{TiO}_3$   
 TRI(RUTILE).4(110)53.30A.  
 100 hr  
 COLLECTED SPALL  
 $\text{NiO}$   
 SPINEL.  $\theta_0=8.25A.$   
 SPINEL.  $\theta_0=8.10A.$

FACE CENTERED CUBIC MATRIX

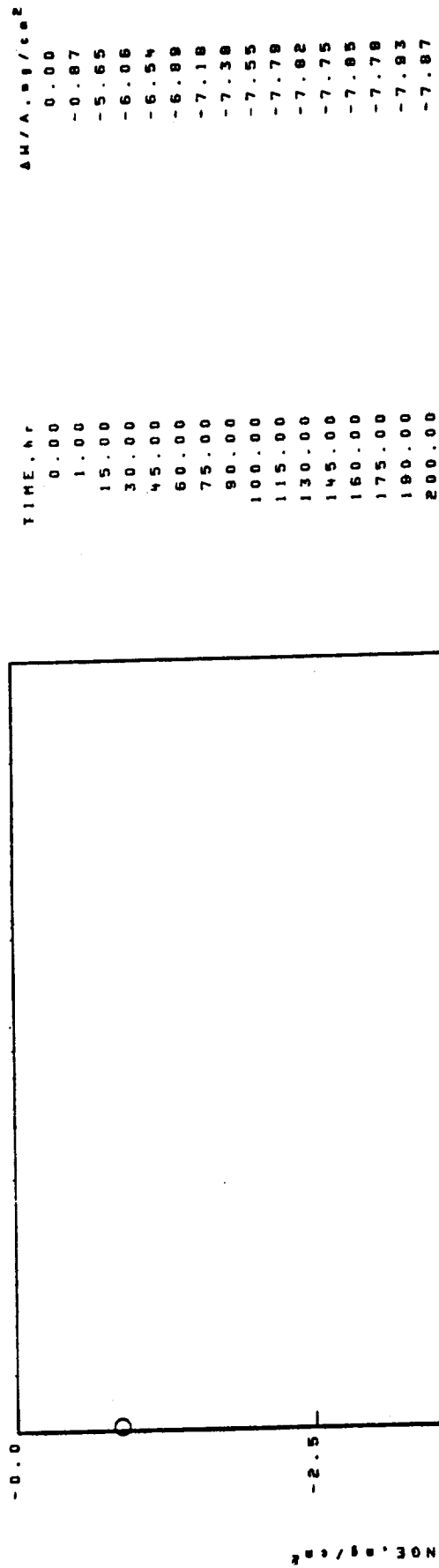
200 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.10A.$   
 $\text{Al}_2\text{O}_3$   
 $(\text{Ni},\text{Co},\text{Fe})\text{TiO}_3$   
 TRI(RUTILE).4(110)53.30A.  
 SPINEL.  $\theta_0=8.25A.$

FACE CENTERED CUBIC MATRIX

200 hr  
 PROBABLE CROSS-SPALL  
 $\text{NiO}$   
 SPINEL.  $\theta_0=8.25A.$

MI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-015-610-2  
 U-700 (M.G.-2) 1100°C 1.00hr CYCLES 200.00hr TEST 2.295mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 U-700(M.O.-2)  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.296mm THICK STATIC AIR  
 02-13-015-610-2

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL,  $\theta_0=8.25A$ .  
 TRI(RUTILE).4(110)13.30A.  
 Al<sub>2</sub>O<sub>3</sub>  
 SPALL  
 1 hr  
 COLLECTED SPALL  
 SPINEL,  $\theta_0=8.25A$ .  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL,  $\theta_0=8.18A$ .  
 Al<sub>2</sub>O<sub>3</sub>  
 (Ni,Cr,F)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL,  $\theta_0=8.25A$ .  
 Ni(Mn)O, TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 SPINEL,  $\theta_0=8.18A$ .  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)13.30A.  
 SPINEL,  $\theta_0=8.25A$ .  
 (Ni,Cr,F)TiO<sub>3</sub>

200 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 SPINEL,  $\theta_0=8.25A$ .  
 UNKNOWN LINES, 4 VALUES  
 2.83A.

FACE CENTERED CUBIC MATRIX



## NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.302mm

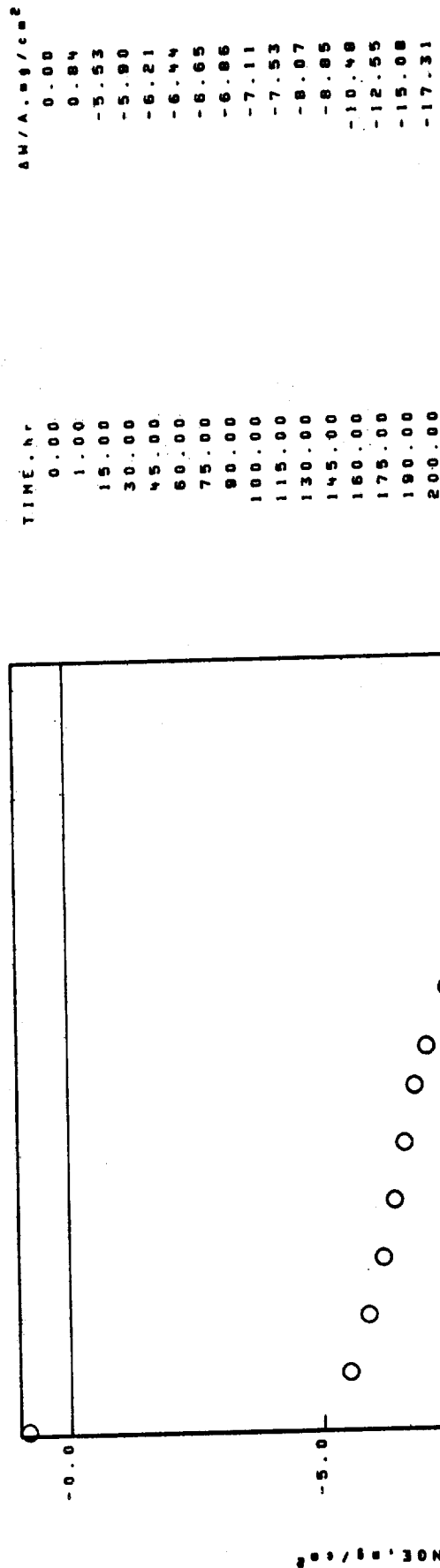
TEST 200.00hr

1.00hr CYCLES

1100°C

U-700 CAST(DURADYNE-1)

## SPECIFIC WEIGHT CHANGE DATA



N1 BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-048-610-3

U-700 CAST(DURADYNE-1)

1100°C 1.00hr CYCLES 200.00hr TEST 2.302mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL  
1 hr

STANDARD SURFACE  
NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).d(110)13.30A.  
ZrO<sub>2</sub>

FACE CENTERED CUBIC MATRIX

100 hr  
COLLECTED SPALL  
NiO  
SPINEL.  $\theta$ -8.25A.  
SPINEL.  $\theta$ -8.10A.  
Ni(W.M.)O, TYPE 2

100 hr  
STANDARD SURFACE  
SPINEL.  $\theta$ -8.10A.  
Al<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).d(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr  
PROBABLE CROSS-SPALL  
NiO  
SPINEL.  $\theta$ -8.25A.  
UNKNOWN LINES.  $\theta$  VALUES  
2.83A.

200 hr  
STANDARD SURFACE  
SPINEL.  $\theta$ -8.10A.  
Al<sub>2</sub>O<sub>3</sub>  
TRI(RUTILE).d(110)13.30A.  
(M1.Co.Fe)TiO<sub>3</sub>  
NiO  
Cr<sub>2</sub>O<sub>3</sub>  
SPINEL.  $\theta$ -8.25A.

FACE CENTERED CUBIC MATRIX

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

COSAM U-700-17.0C°

1100°C

1.00hr CYCLES

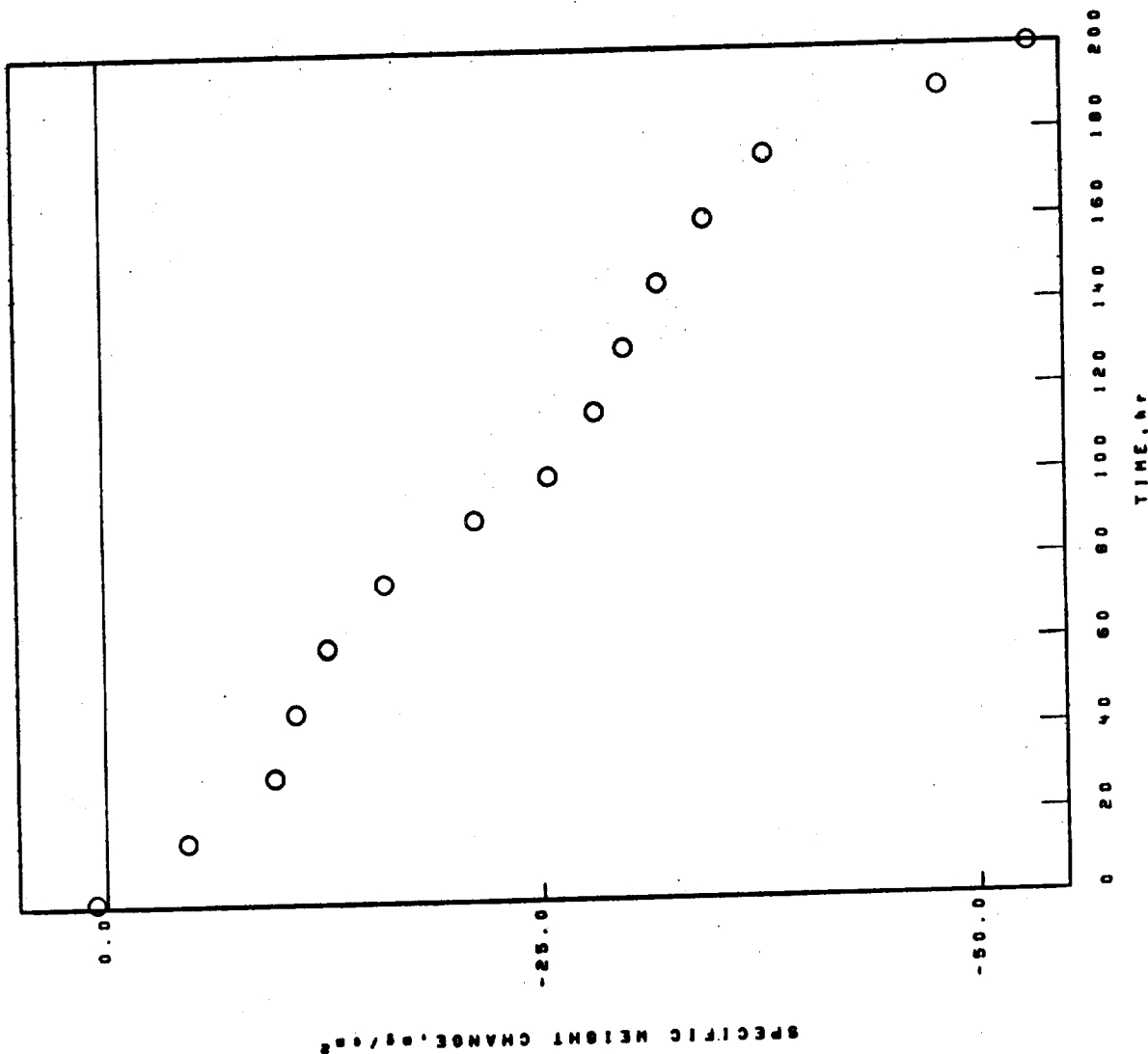
200.00hr TEST

2.416mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.63
15.00	-4.63
30.00	-9.68
45.00	-10.92
60.00	-12.75
75.00	-16.07
90.00	-21.26
100.00	-25.52
115.00	-28.16
130.00	-29.09
145.00	-31.87
160.00	-34.55
175.00	-38.04
190.00	-48.03
200.00	-53.16



NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-101-610-5

COSAM U-700-17.0C.

1100°C 1.00hr CYCLES 200.00hr TEST 2.416mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

Al<sub>2</sub>O<sub>3</sub>

SPALL

1 hr

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES. 4 VALUES

3.32A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL. 80-8.25A.

(Ni.Co.Fe)TiO<sub>3</sub>

SPINEL. 80-8.10A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

100 hr

COLLECTED SPALL

NiO

SPINEL. 80-8.25A.

SPINEL. 80-8.10A.

(Ni.Co.Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

NiO

SPINEL. 80-8.25A.

(Ni.Co.Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

SPINEL. 80-8.10A.

200 hr

COLLECTED SPALL

NiO

SPINEL. 80-8.25A.

02-09-101-655-5

# NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

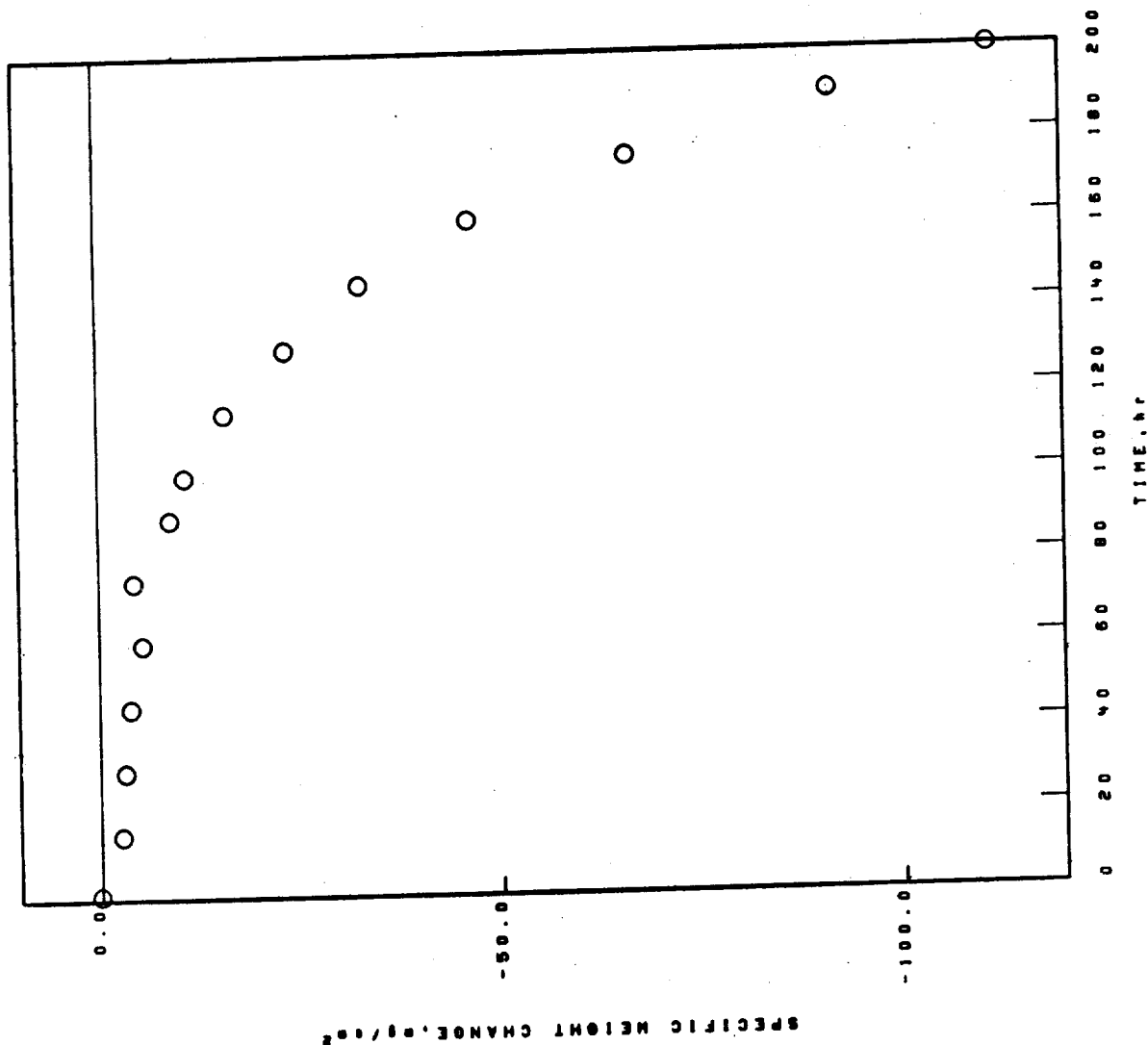
THICK 2.280mm TEST 200.00hr

1100°C 1.00hr CYCLES

COSAM U-700-17.0C.

## SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	0.11
15.00	-2.63
30.00	-3.07
45.00	-3.83
60.00	-5.36
75.00	-4.37
90.00	-8.98
100.00	-10.82
115.00	-15.05
130.00	-23.46
145.00	-32.89
160.00	-46.51
175.00	-66.25
190.00	-81.37
200.00	-111.17



NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-101-655-5

COSAM U-700-17.0C.

1100°C 1.00hr CYCLES 200.00hr TEST 2.280mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL,  $a_0=8.25A$ .

TRI(RUTILE),  $d(110) \leq 3.30A$ .

Al<sub>2</sub>O<sub>3</sub>

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL,  $a_0=8.10A$ .

SPINEL,  $a_0=8.25A$ .

(Ni,Cr,F)TiO<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

TRI(RUTILE),  $d(110) \leq 3.30A$ .

Cr<sub>2</sub>O<sub>3</sub>

100 hr

COLLECTED SPALL

SPINEL,  $a_0=8.25A$ .

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL,  $a_0=8.10A$ .

TRI(RUTILE),  $d(110) \leq 3.30A$ .

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL,  $a_0=8.30A$ .

NiO

Cr<sub>2</sub>O<sub>3</sub>

200 hr

COLLECTED SPALL

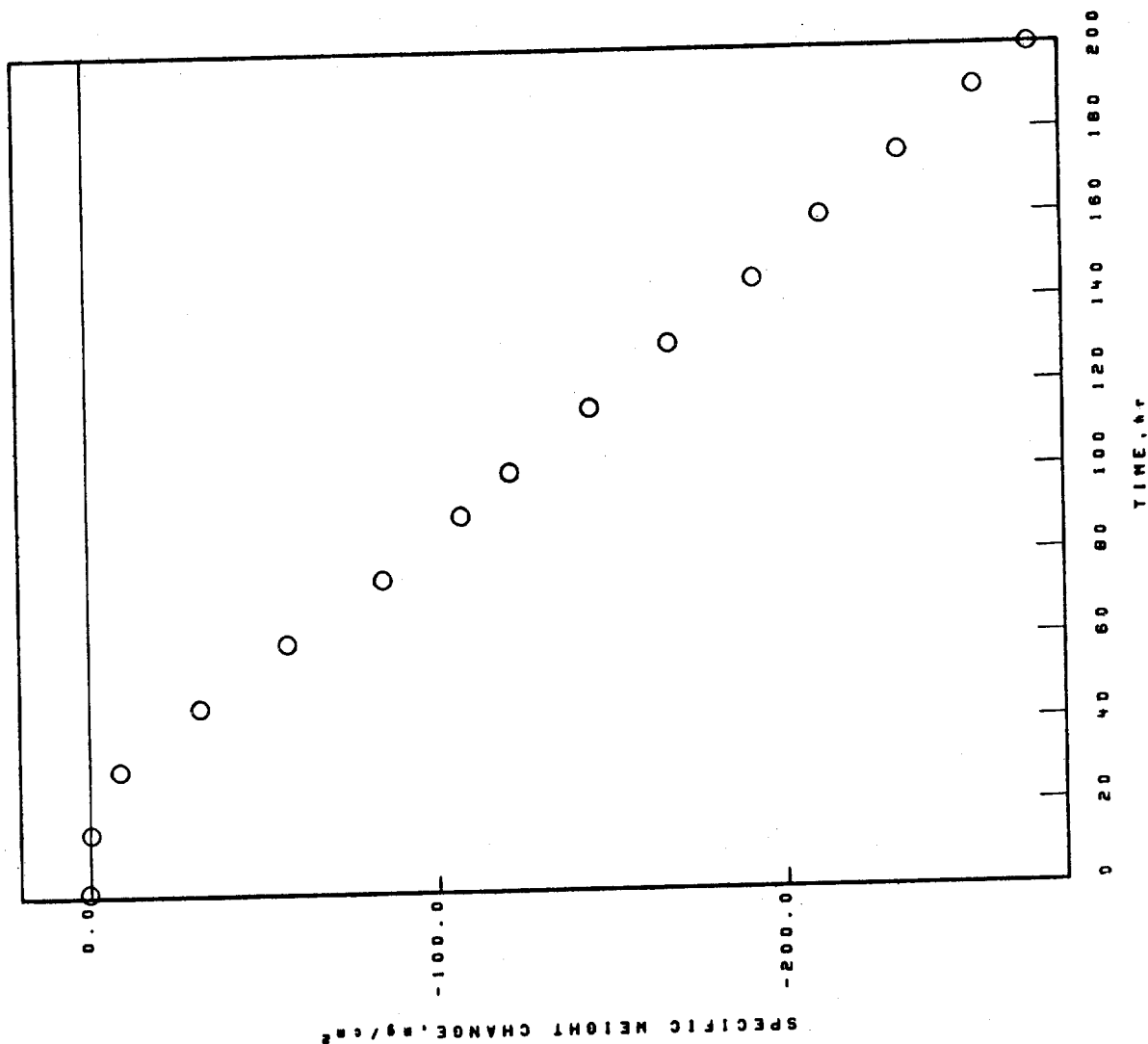
NiO

SPINEL,  $a_0=8.25A$ .

FACE CENTERED CUBIC MATRIX

NI BASE  
 H-55 (UDIMET-700)  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.242mm THICK  
 02-09-081-655-6  
 STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS 02-09-001-655-8  
 M-55(UDIMET-700) 1100°C 1.00hr CYCLES 200.00hr TEST 2.242mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRIRUTILE).4(110)33.30A.  
 SPINEL. 00-0.25A.  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL. 00-0.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 SPINEL. 00-0.10A.  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 00-0.25A.  
 Ni(W.M.)O, TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL. 00-0.10A.

200 hr  
 STANDARD SURFACE  
 SPINEL. 00-0.30A.  
 NiO  
 Cr<sub>2</sub>O<sub>3</sub>  
 Ni(W.M.)O, TYPE 2  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL. 00-0.25A.  
 Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX



02-04-043-679-1

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

THICK

2.288

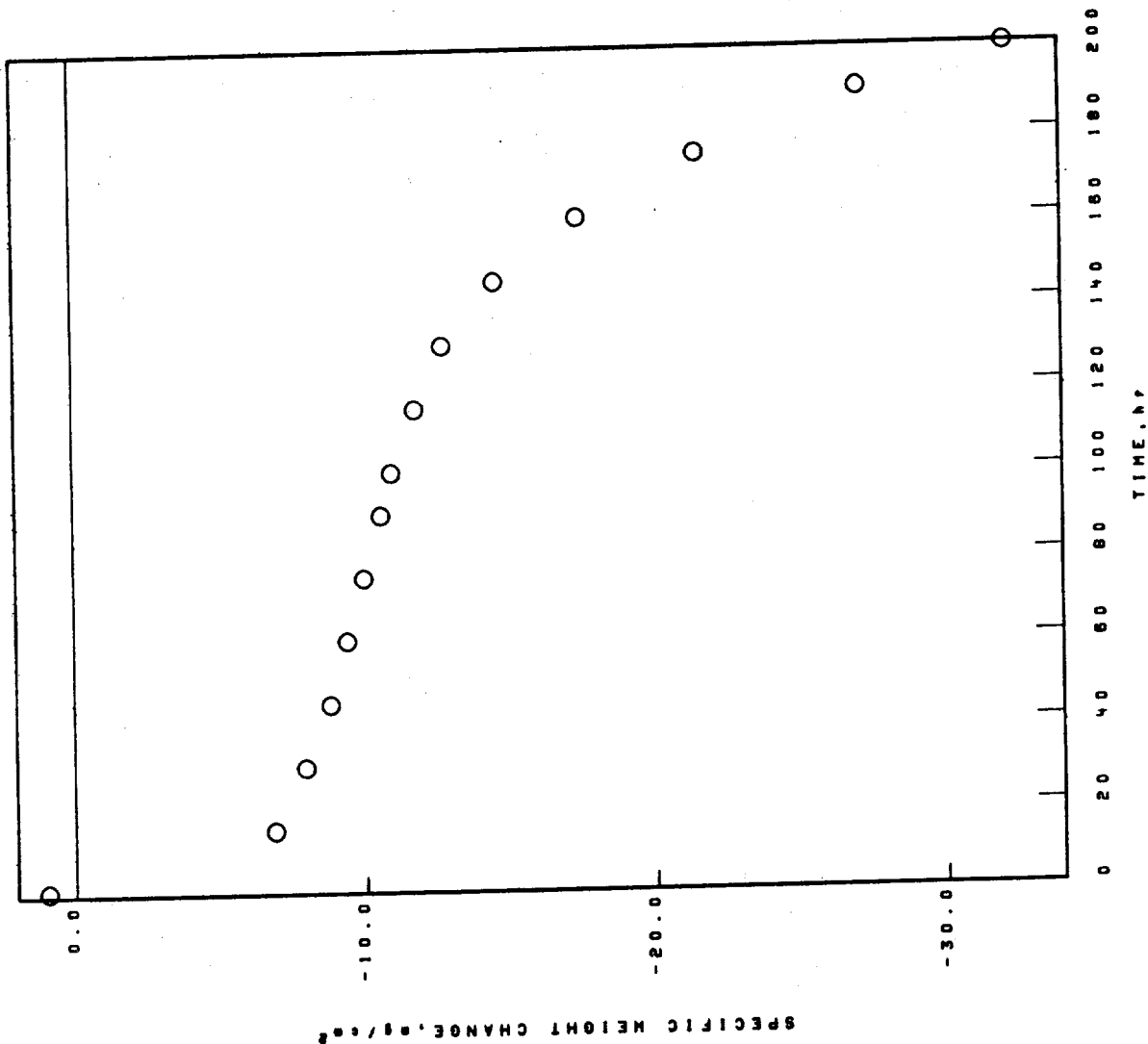
TEST 200.00hr

1.00hr CYCLES

1100°C

U-700 CAST(SMP-1)

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.96
15.00	-6.85
30.00	-7.94
45.00	-8.81
60.00	-9.41
75.00	-9.98
90.00	-10.60
100.00	-10.97
115.00	-11.78
130.00	-12.75
145.00	-14.56
160.00	-17.42
175.00	-21.50
190.00	-27.07
200.00	-32.13

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-678-1  
 U-700 CAST(SMP-1) 1100°C 1.00hr CYCLES 200.00hr TEST 2.208mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 $\text{Cr}_2\text{O}_3$   
 $\text{TRI(RUTILE).4(110)53.30A.}$   
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.10A.$   
 $\text{Al}_2\text{O}_3$   
 $(\text{Ni.Ce.Fe})\text{TiO}_3$   
 $\text{TRI(RUTILE).4(110)53.30A.}$   
 $\text{Cr}_2\text{O}_3$   
 100 hr  
 PROBABLE CROSS-SPALL  
 $\text{NiO}$   
 SPINEL.  $\theta_0=9.30A.$

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.10A.$   
 $\text{NiO}$   
 $\text{TRI(RUTILE).4(110)53.30A.}$   
 $(\text{Ni.Ce.Fe})\text{TiO}_3$   
 $\text{Cr}_2\text{O}_3$   
 $\text{Ni(W.Mo)O, TYPE 2}$   
 SPINEL.  $\theta_0=8.35A.$   
 $\text{Al}_2\text{O}_3$   
 $\text{Ni(W.Mo)O, TYPE 1}$   
 200 hr  
 PROBABLE CROSS-SPALL  
 $\text{NiO}$   
 SPINEL.  $\theta_0=8.35A.$

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

U-700 CAST(SMP-1)

1100°C

1.00hr CYCLES

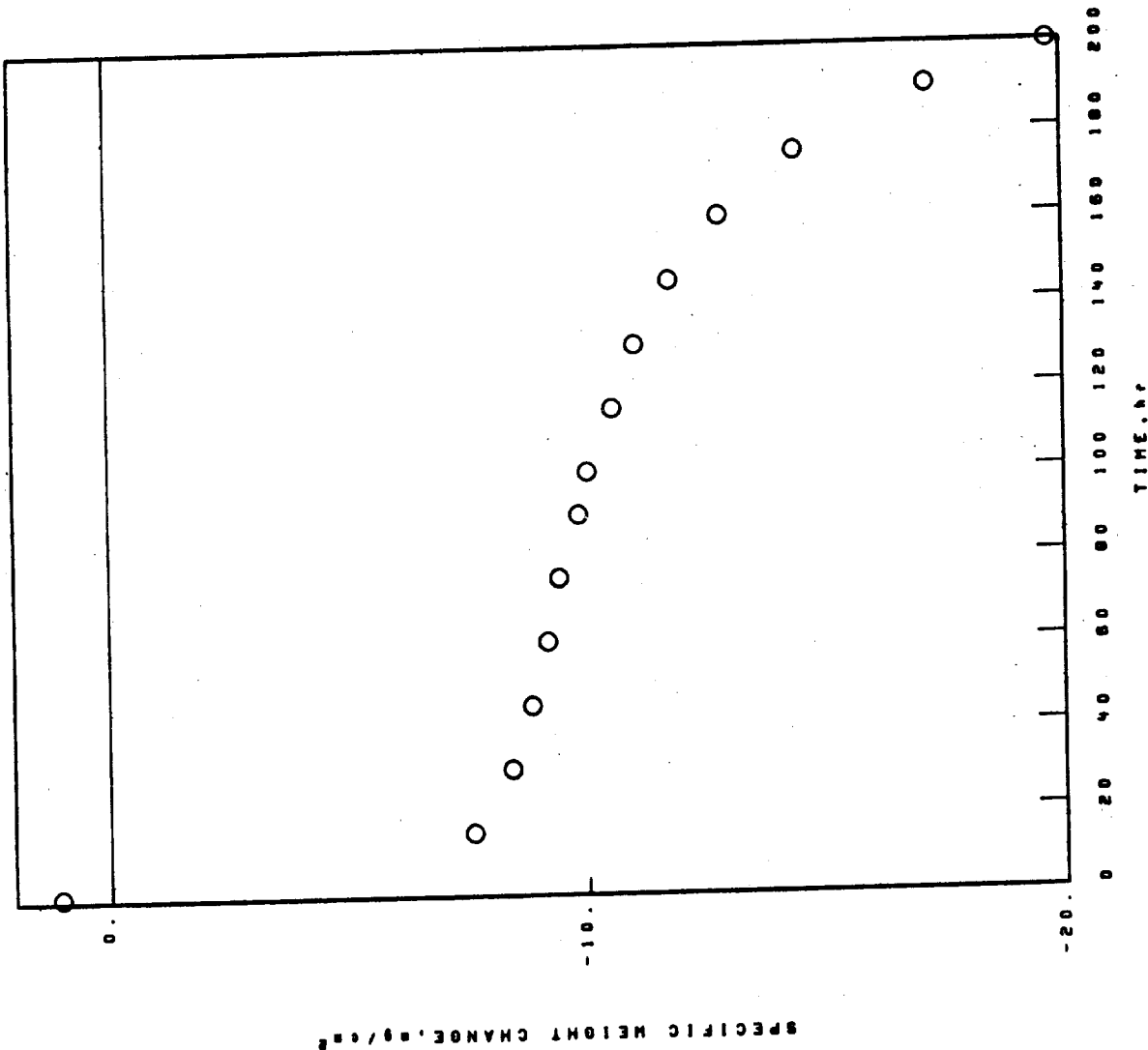
200.00hr TEST

2.290mm THICK

STATIC AIR

SPECIFIC HEIGHT CHANGE DATA

TIME, hr	$\Delta H/A, \text{mg/cm}^2$
0.00	0.00
1.00	1.04
15.00	-7.60
30.00	-8.42
45.00	-8.84
60.00	-9.18
75.00	-9.43
90.00	-9.85
100.00	-10.04
115.00	-10.57
130.00	-11.08
145.00	-11.79
160.00	-12.84
175.00	-14.44
190.00	-17.19
200.00	-19.72



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-043-678-2  
 U-700 CAST(SMP-1)                      1100°C                      1.00hr CYCLES                      200.00hr TEST                      2-290mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
   1 hr  
 STANDARD SURFACE  
   Cr<sub>2</sub>O<sub>3</sub>  
   TRI(RUTILE).4(110)53.30A.  
 SPALL  
   1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
   SPINEL. 88-8.10A.  
   Al<sub>2</sub>O<sub>3</sub>  
   (Ni.Co.Fe)TiO<sub>3</sub>  
   TRI(RUTILE).4(110)53.30A.  
 100 hr  
 PROBABLE CROSS-SPALL  
   NiO  
   SPINEL. 88-8.30A.  
   SPINEL. 88-8.10A.  
   Ni(W.Mo)O, TYPE 2

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
   SPINEL. 88-8.10A.  
   NiO  
   TRI(RUTILE).4(110)53.30A.  
   (Ni.Co.Fe)TiO<sub>3</sub>  
   Cr<sub>2</sub>O<sub>3</sub>  
   Ni(W.Mo)O, TYPE 2  
   SPINEL. 88-8.35A.  
   Al<sub>2</sub>O<sub>3</sub>  
   Ni(W.Mo)O, TYPE 1  
 200 hr  
 PROBABLE CROSS-SPALL  
   NiO  
   SPINEL. 88-8.35A.

FACE CENTERED CUBIC MATRIX

02-04-043-680-1

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

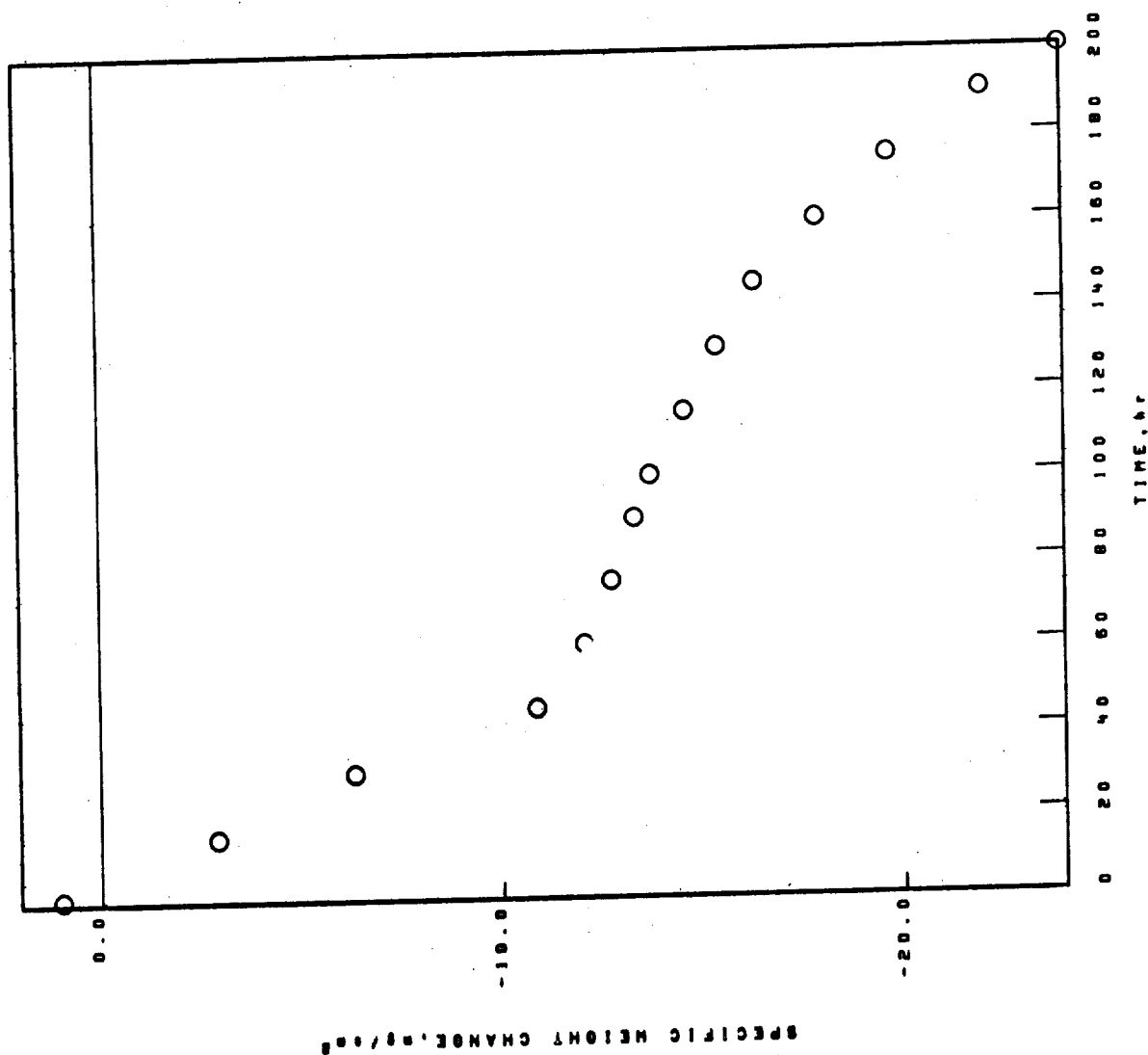
2.290mm THICK

1100°C 1.00hr CYCLES 200.00hr TEST

U-700 CAST(SMP-1)

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	0.87
15.00	-2.91
30.00	-6.33
45.00	-10.87
60.00	-12.07
75.00	-12.76
90.00	-13.33
100.00	-13.73
115.00	-14.58
130.00	-15.41
145.00	-16.35
160.00	-17.90
175.00	-19.69
190.00	-22.01
200.00	-23.87



NI BASE  
 U-700 CAST(SMP-1)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.290mm THICK STATIC AIR  
 02-04-043-600-1

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.

SPINEL.  $\theta_0$ -8.30A.

(Ni,Co,Fe)TiO<sub>3</sub>

NiO

TRI(RUTILE).4(110)S3.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.10A.

NiO

TRI(RUTILE).4(110)S3.30A.

(Ni,Co,Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

Ni(W,M)O<sub>4</sub> TYPE 2

SPINEL.  $\theta_0$ -8.35A.

Al<sub>2</sub>O<sub>3</sub>

Ni(W,M)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta_0$ -8.30A.

200 hr

PROBABLE CROSS-SPALL

NiO

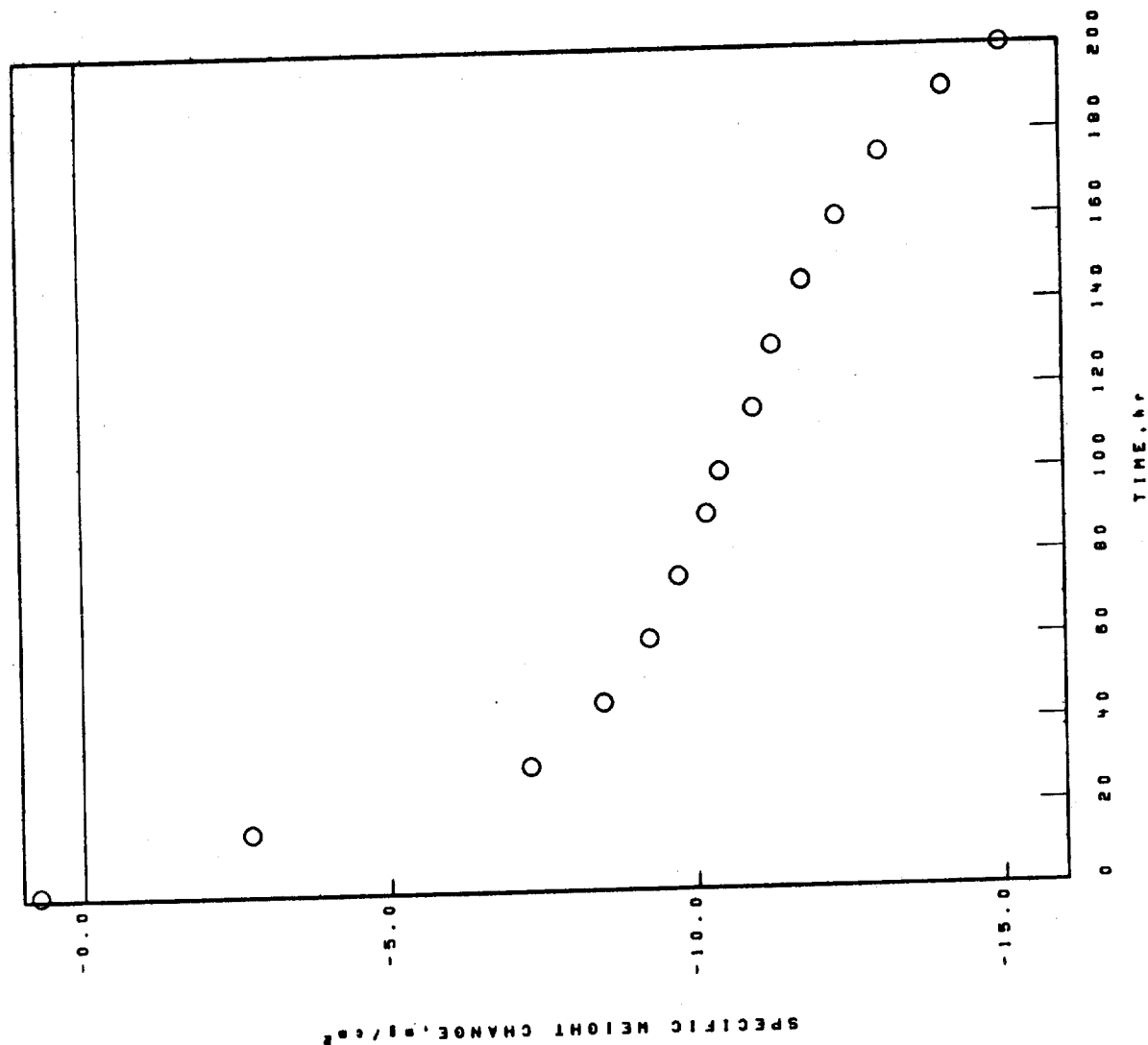
SPINEL.  $\theta_0$ -8.35A.

## N1 BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

U-700 CAST(SMP-1)

1100°C 1.00hr CYCLES 200.00hr TEST 2.292mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-043-680-2

U-700 CAST(SMP-1)

1100°C 1.00hr CYCLES 200.00hr TEST 2.292mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

PROBABLE CROSS-SPALL

SPINEL. 00-0.10A.

NiO

SPINEL. 00-0.30A.

SPINEL. 00-0.30A.

NiO

(Ni<sub>1</sub>Co<sub>1</sub>Fe<sub>1</sub>)TiO<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

PROBABLE CROSS-SPALL

SPINEL. 00-0.10A.

NiO

NiO

TRI(RUTILE).4(110)53.30A.

(Ni<sub>1</sub>Co<sub>1</sub>Fe<sub>1</sub>)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

Ni(M<sub>1</sub>M<sub>2</sub>)O<sub>4</sub> TYPE 2

SPINEL. 00-0.35A.

Al<sub>2</sub>O<sub>3</sub>

Ni(M<sub>1</sub>M<sub>2</sub>)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX



02-13-016-610-4

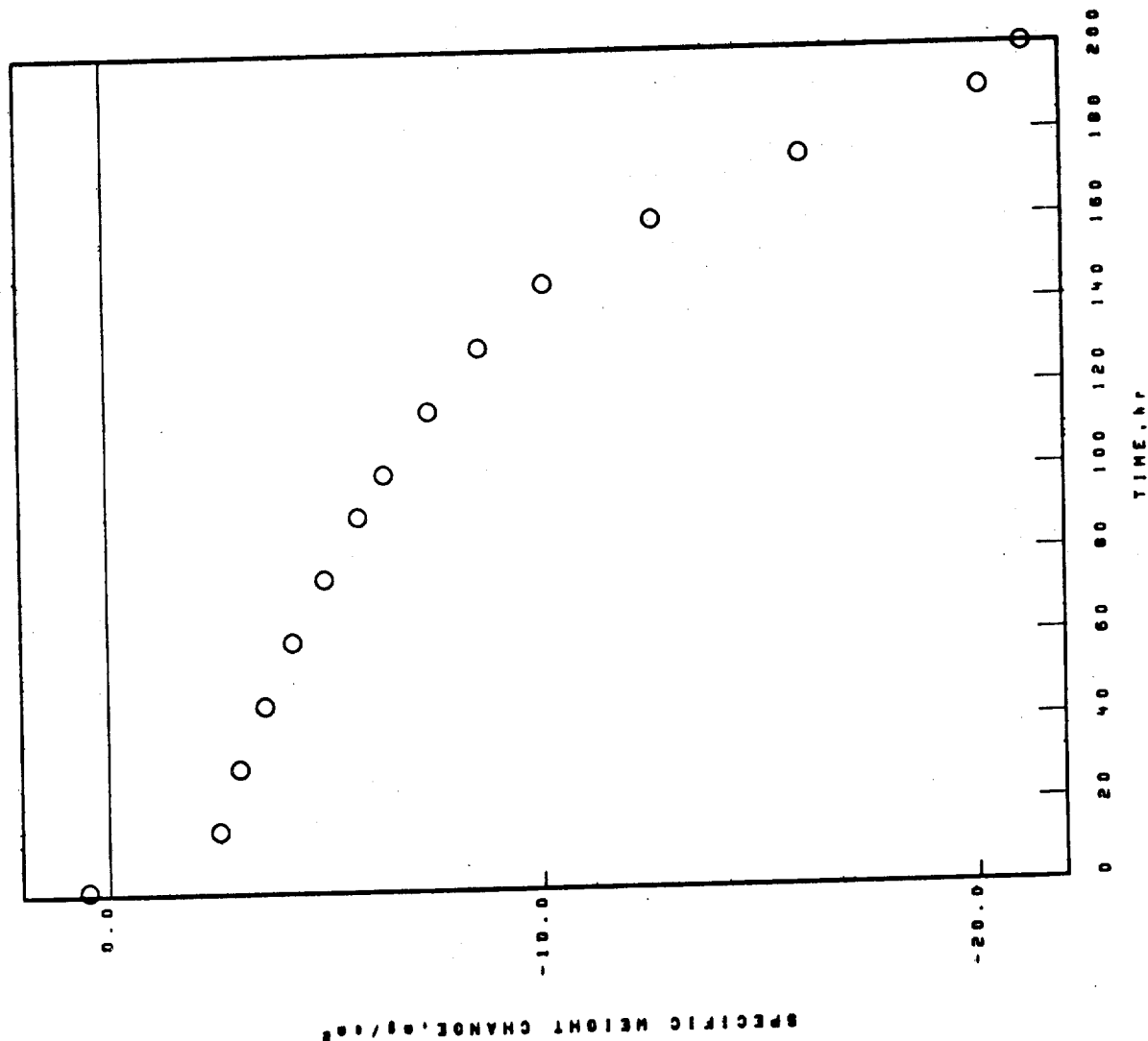
W1 BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

U-700 (H.G.--STD.)

1100°C 1.00hr CYCLES 200.00hr TEST 2.260mm THICK STATIC AIR

SPECIFIC HEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.48
15.00	-2.54
30.00	-3.01
45.00	-3.60
60.00	-4.25
75.00	-5.01
90.00	-5.80
100.00	-6.41
115.00	-7.44
130.00	-8.51
145.00	-10.11
160.00	-12.61
175.00	-16.03
190.00	-20.16
200.00	-21.16



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-018-610-4  
 U-700(M.G.-STD.) 1100°C 1.00hr CYCLES 200.00hr TEST 2.260mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$ -8.18A.  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$ -8.10A.  
 ZrO<sub>2</sub>  
 (Ni.Co.Fe)TiO<sub>3</sub>

UNKNOWN LINES. 4 VALUES  
 3.34A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta$ -8.18A.  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).  $\theta$ (110)13.30A.  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 NiO

100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 Al<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$ -8.10A.  
 TRI(RUTILE).  $\theta$ (110)13.30A.

200 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 SPINEL.  $\theta$ -8.25A.

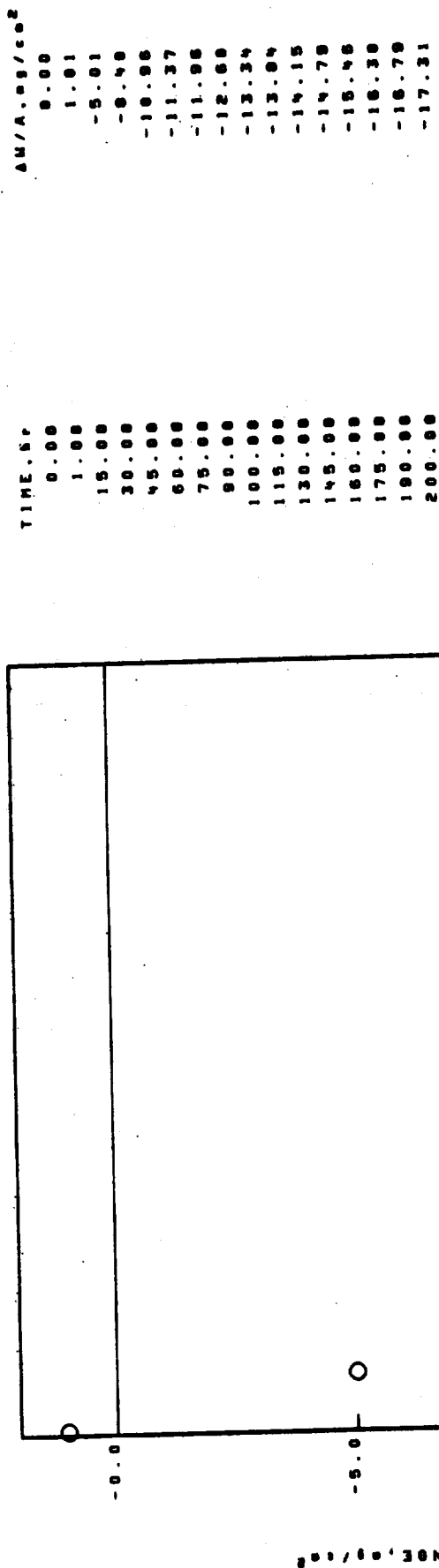
FACE CENTERED CUBIC MATRIX

02-13-025-610-6

NI BASE COMMERCIAL NOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM U-700-17.0C-(MIP) 1100°C 1.00hr CYCLES 200.00hr TEST 2.325hr THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-025-610-6

COSAM U-700-17.8C.(HIP)

1100°C

1.00hr CYCLES 200.00hr TEST 2.325mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

COLLECTED SPALL

SPINEL. 00-8-20A.

NiO

SPINEL. 00-8-10A.

SPINEL. 00-8-25A.

(Ni.Co.Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

NiO

SPINEL. 00-8-10A.

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

COLLECTED SPALL

(Ni.Co.Fe)TiO<sub>3</sub>

NiO

NiO

SPINEL. 00-8-20A.

SPINEL. 00-8-25A.

SPINEL. 00-8-10A.

Cr<sub>2</sub>O<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

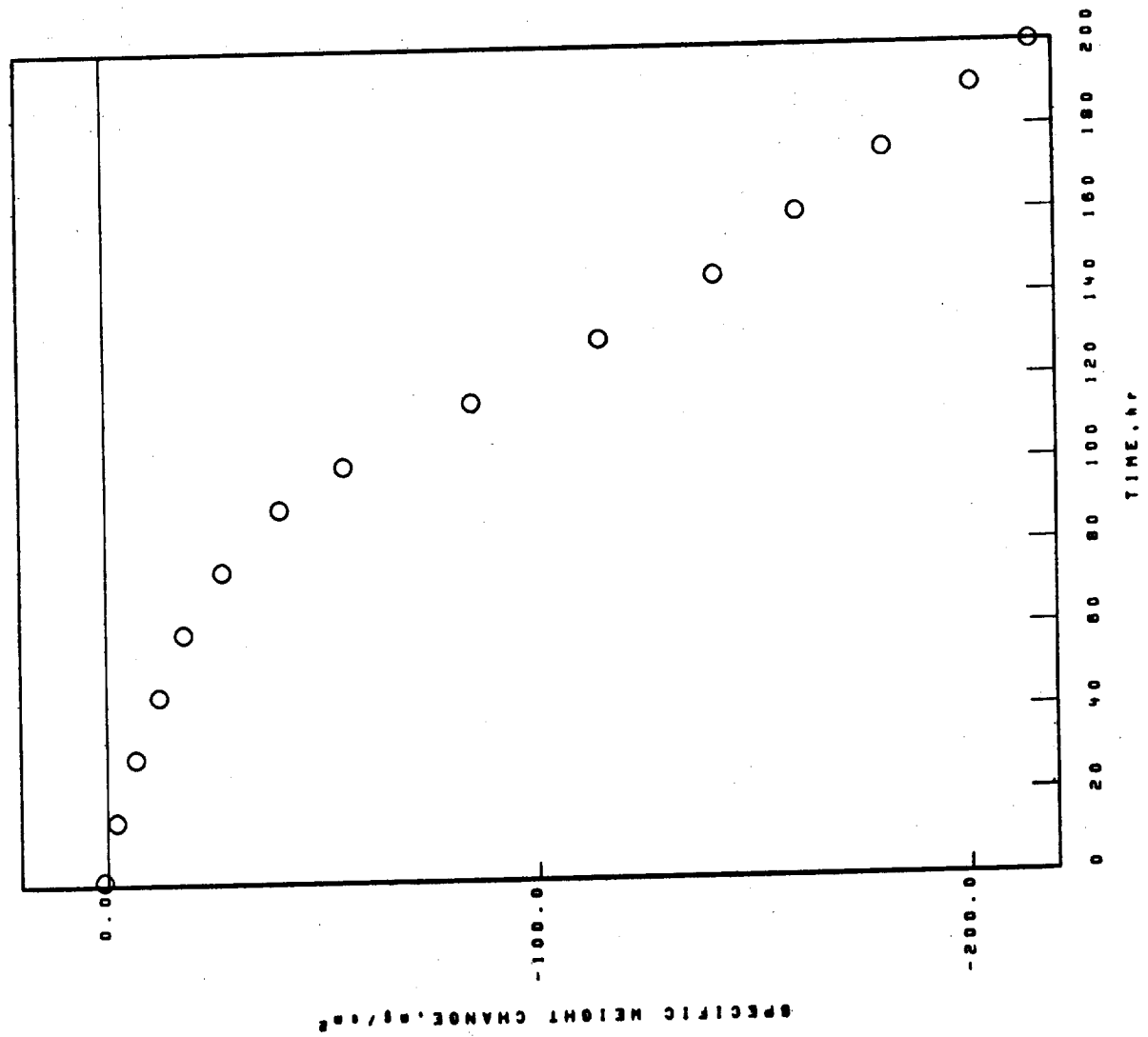
TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

NI BASE  
 U-700(R.M.)  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.250mm THICK STATIC AIR  
 02-13-017-655-4

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.96
15.00	-2.10
30.00	-6.64
45.00	-12.16
60.00	-18.04
75.00	-27.01
90.00	-40.43
100.00	-55.35
115.00	-85.17
130.00	-114.78
145.00	-141.37
160.00	-160.52
175.00	-180.61
190.00	-201.12
200.00	-214.85



N1 BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-017-655-4

U-700(R.M.)

1100°C 1.00hr CYCLES 200.00hr TEST 2.250mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

SPINEL.  $\theta_0$ =8.25A.

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta_0$ =8.25A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni,Ce,Fe)TiO<sub>3</sub>

Ni(W.M.)O<sub>4</sub> TYPE 2

TRI(RUTILE).4(110)13.30A.

100 hr

COLLECTED SPALL

NiO

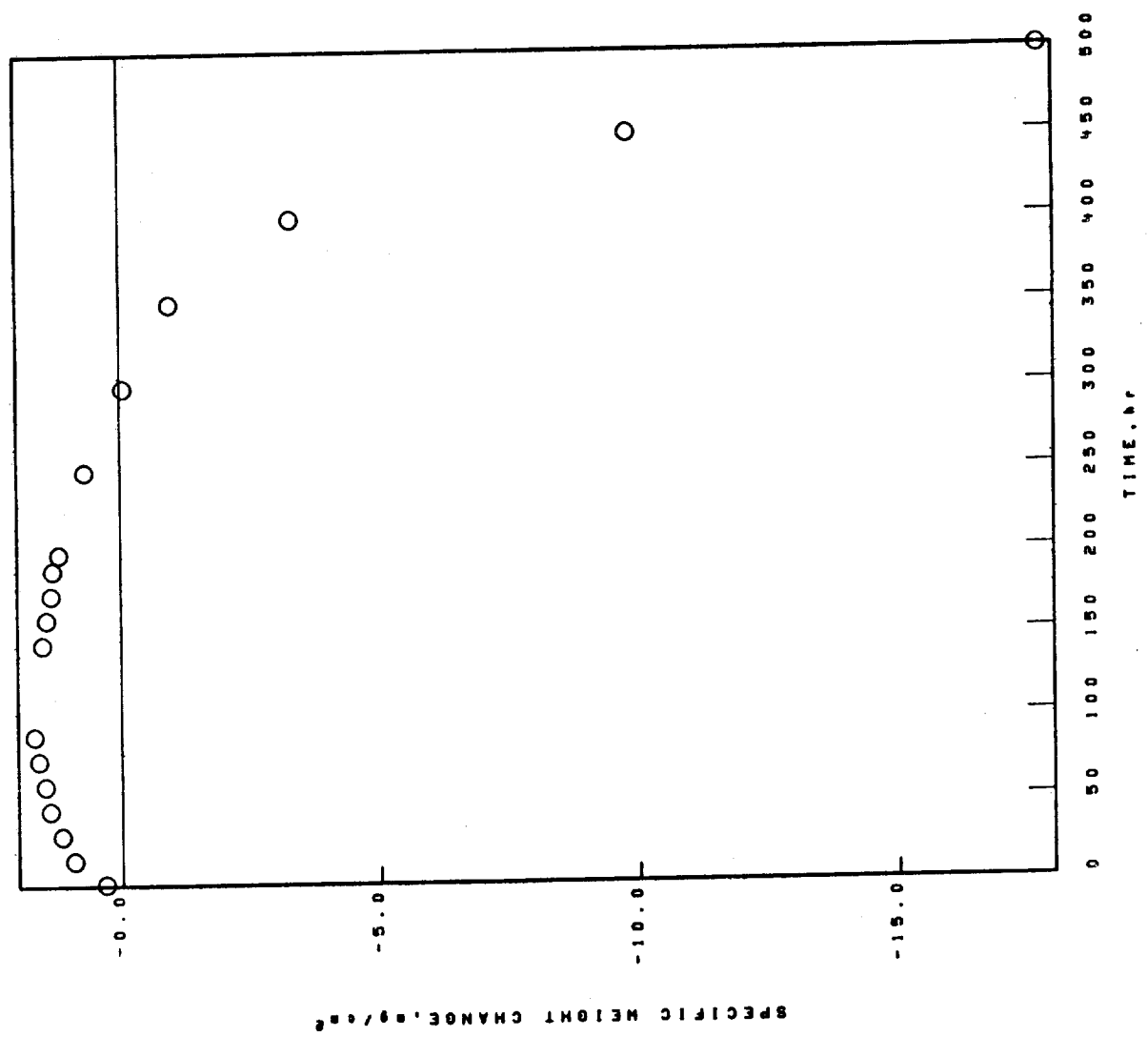
SPINEL.  $\theta_0$ =8.25A.

Ni(W.M.)O<sub>4</sub> TYPE 2

FACE CENTERED CUBIC MATRIX

NI BASE  
 U-700 CAST (SMP-1)  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1000°C 1.00hr CYCLES 500.00hr TEST 2.360mm THICK STATIC AIR  
 02-04-043-436-1

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-438--1  
 U-700 CAST(SMP-1) 1000°C 1.00hr CYCLES 500.00hr TEST 2.360mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL  
 1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>  
 .12 Cr-.78 Ti-1.74 O  
 TRI(RUTILE).4(110)53.30A.

200 hr

COLLECTED SPALL

SPINEL. 90-8.30A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 NiO

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

SPINEL. 90-8.25A.  
 SPINEL. 90-8.15A.  
 Al<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.

500 hr

COLLECTED SPALL

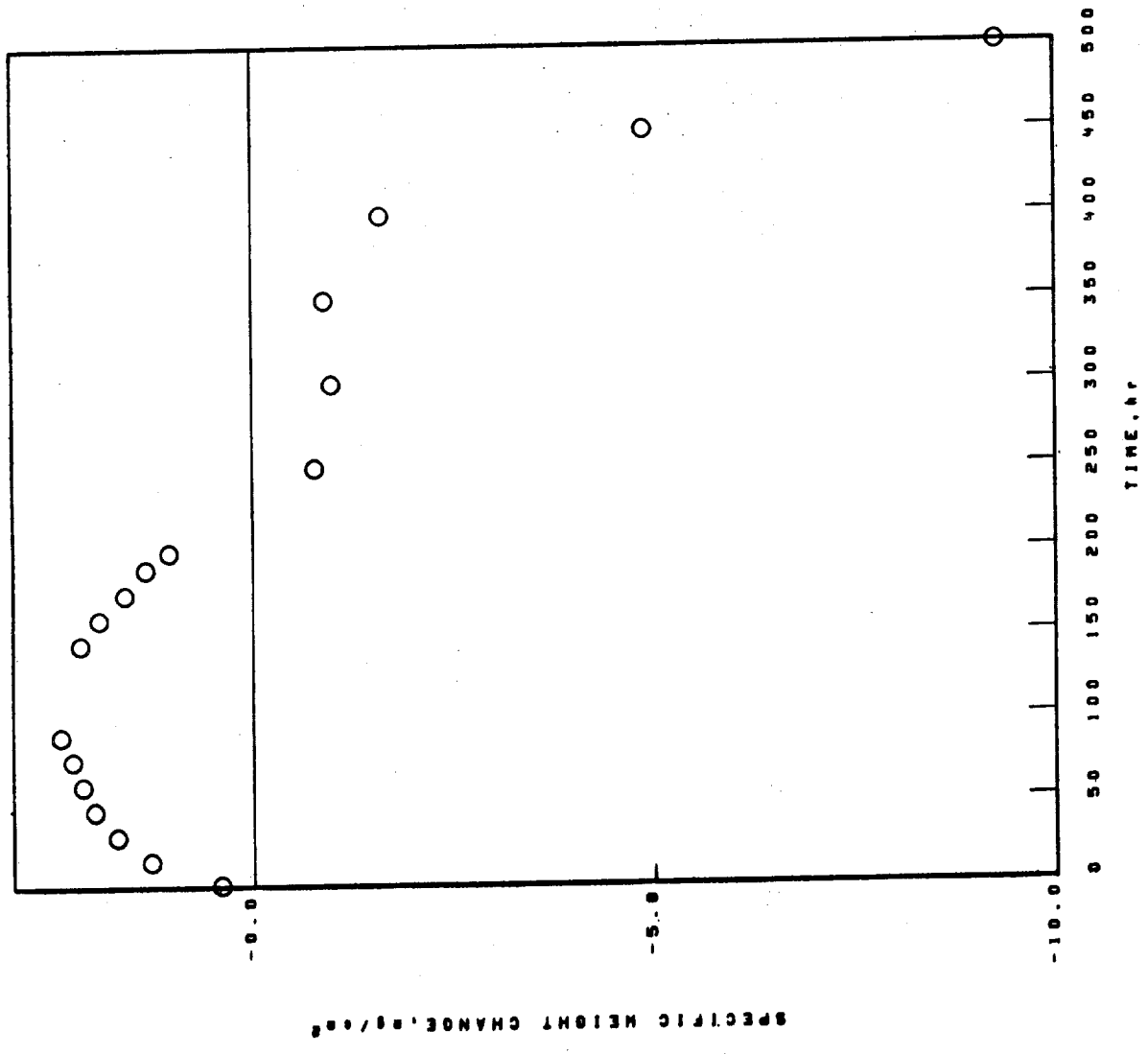
NiO  
 SPINEL. 90-8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Cr,F)TiO<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPINEL. 90-8.10A.

FACE CENTERED CUBIC MATRIX



NI BASE  
 COSAM U-700-17.0C  
 EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1000°C 1.00hr CYCLES 500.00hr TEST 2.418mm THICK STATIC AIR  
 02-09-101-436-2

SPECIFIC WEIGHT CHANGE DATA



NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-101-438-2

COSAM U-700-17-0C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.418mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8.30A.

.12 Cr-.78 Ti-1.7% O

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

NiO

SPINEL. 80-8.25A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8.30A.

NiO

500 hr

COLLECTED SPALL

NiO

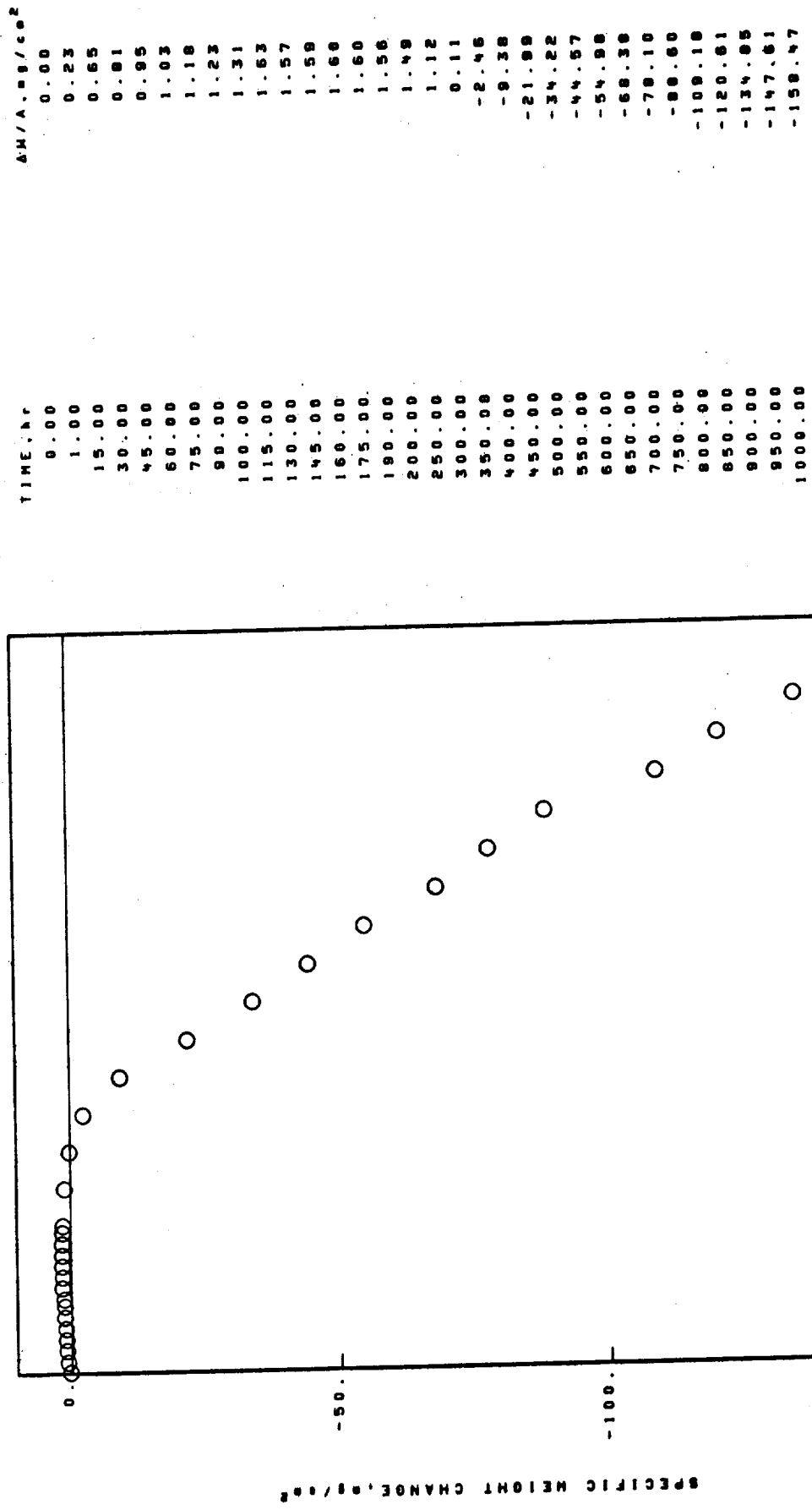
SPINEL. 80-8.25A.

Cr<sub>2</sub>O<sub>3</sub>

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

U-700 CAST(SMP-1) 1000°C 1.00hr CYCLES 1000.00hr TEST 2.306mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS                      02-04-043-452-1  
 U-700 CAST(SMP-1)                      1000°C                      1.00hr CYCLES                      1000.00hr TEST                      2.306mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.35A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.30A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

Al<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

1000 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta_0$ -8.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

NO SIGNIFICANT SPALL OBSERVED

200 hr

COLLECTED SPALL

SPINEL.  $\theta_0$ -8.30A.

Cr<sub>2</sub>O<sub>3</sub>

NiO

TRI(RUTILE).4(110)13.30A.

500 hr

PROBABLE CROSS-SPALL

NiO

SPINEL.  $\theta_0$ -8.30A.

1000 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ -8.30A.

(Ni.Co.Fe)TiO<sub>3</sub>

02-04-043-439-1

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

2.308mm

TEST

1000.00hr

1.00hr

CYCLES

760°C

U-700 CAST(SMP-1)

760°C

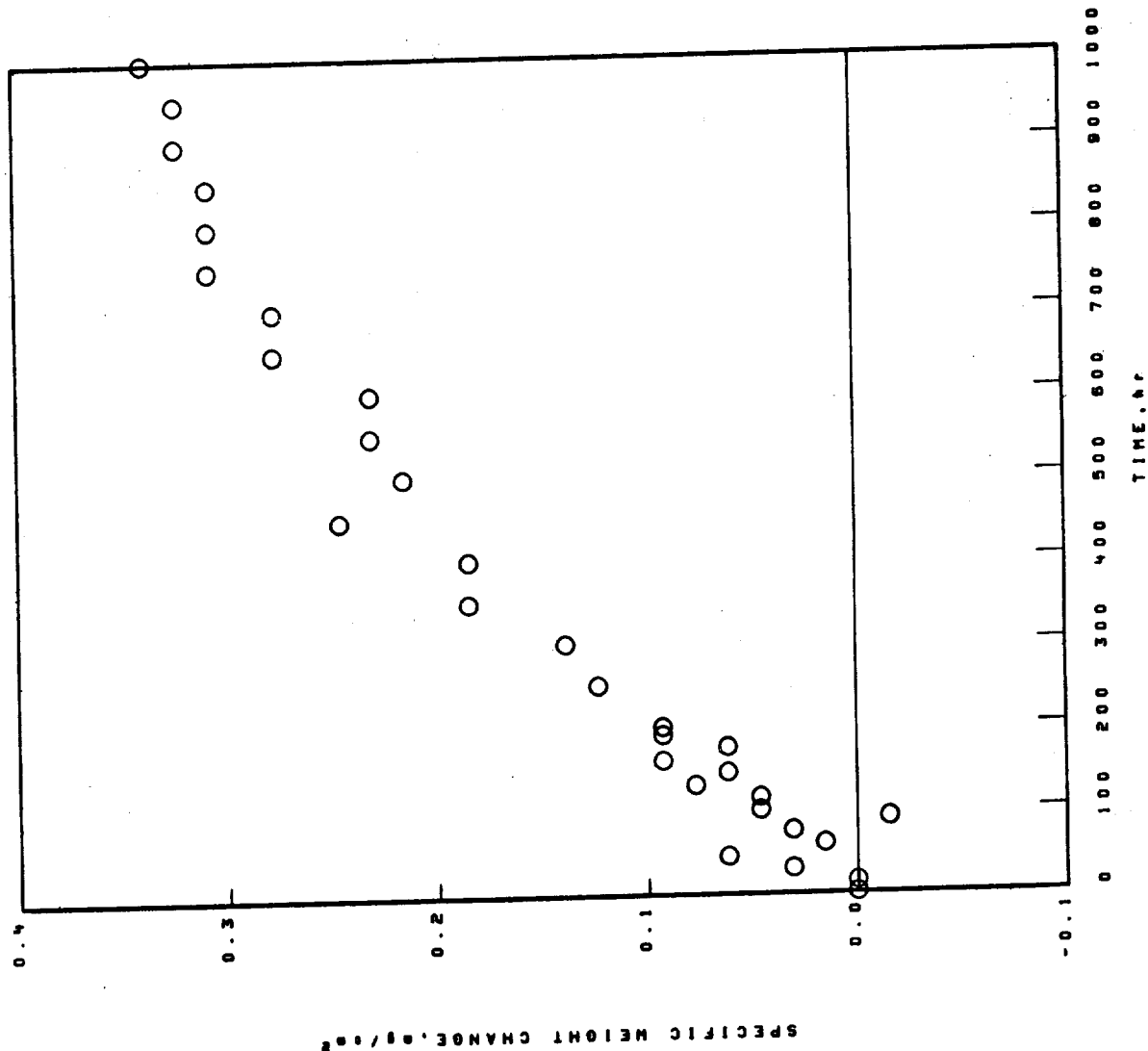
1.00hr

CYCLES

1000.00hr

TEST

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-043-439-1  
 U-700 CAST(SMP-1) 760°C 1.00hr CYCLES 1000.00hr TEST 2.308mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPALL  
 1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 100 hr  
 PROBABLE CROSS-SPALL  
 NiO

FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 200 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

500 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 SPINEL. 0.08.25A.  
 500 hr  
 COLLECTED SPALL  
 NiO

FACE CENTERED CUBIC MATRIX

1000 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)53.30A.  
 1000 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

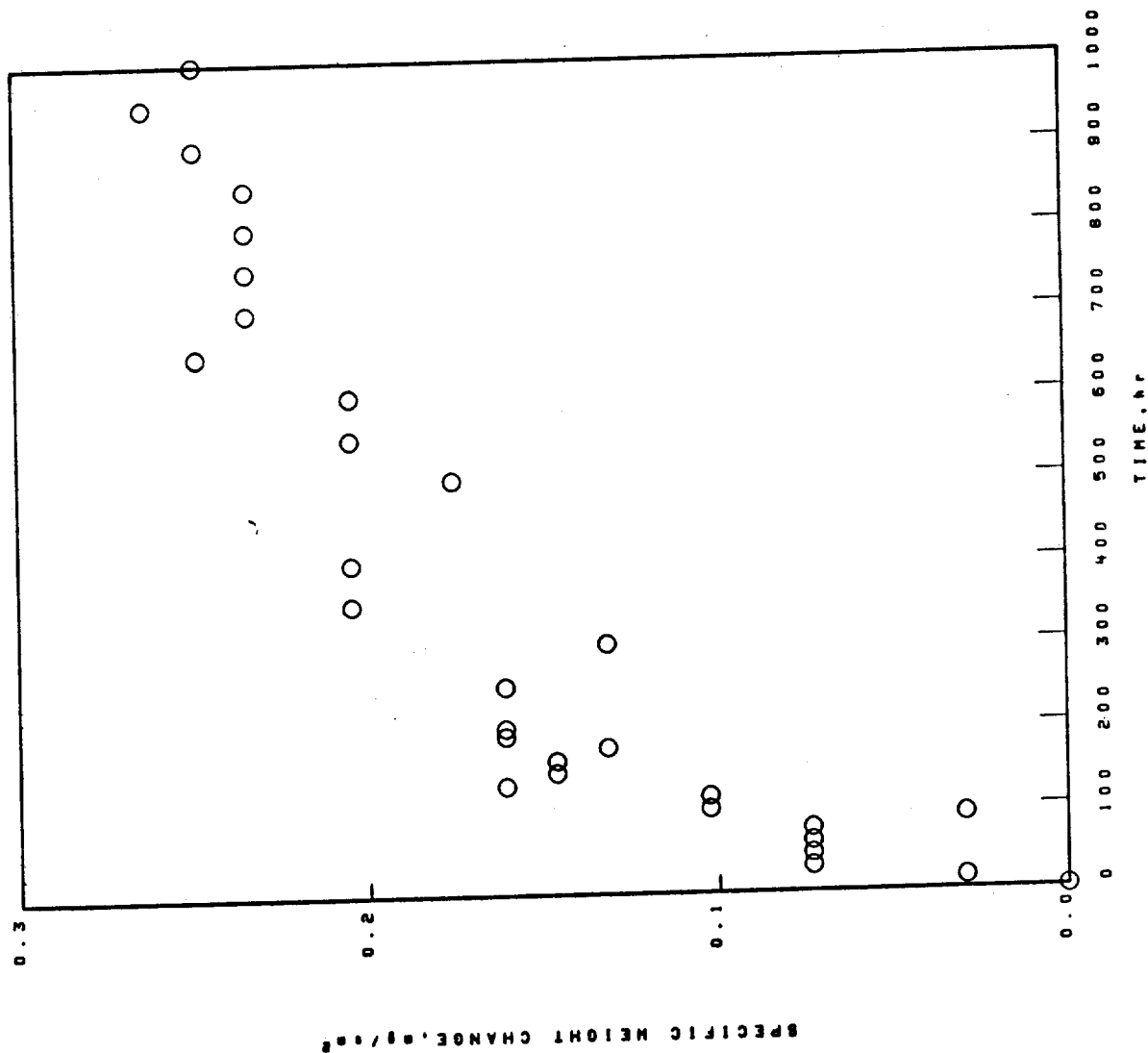
STATIC AIR

THICK 2.422mm

760°C 1.00hr CYCLES 1000.00hr TEST

COSAM U-700-17.0C

SPECIFIC WEIGHT CHANGE DATA



NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-101-439-2

COSAM U-700-17.0C°

760°C 1.00hr CYCLES 1000.00hr TEST 2.422mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

100 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)33.30A.

200 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

500 hr

COLLECTED SPALL

NIO

FACE CENTERED CUBIC MATRIX

1000 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)33.30A.

1000 hr

COLLECTED SPALL

SPINEL. 80-8.25A.

FACE CENTERED CUBIC MATRIX



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST 2.329

100.00hr

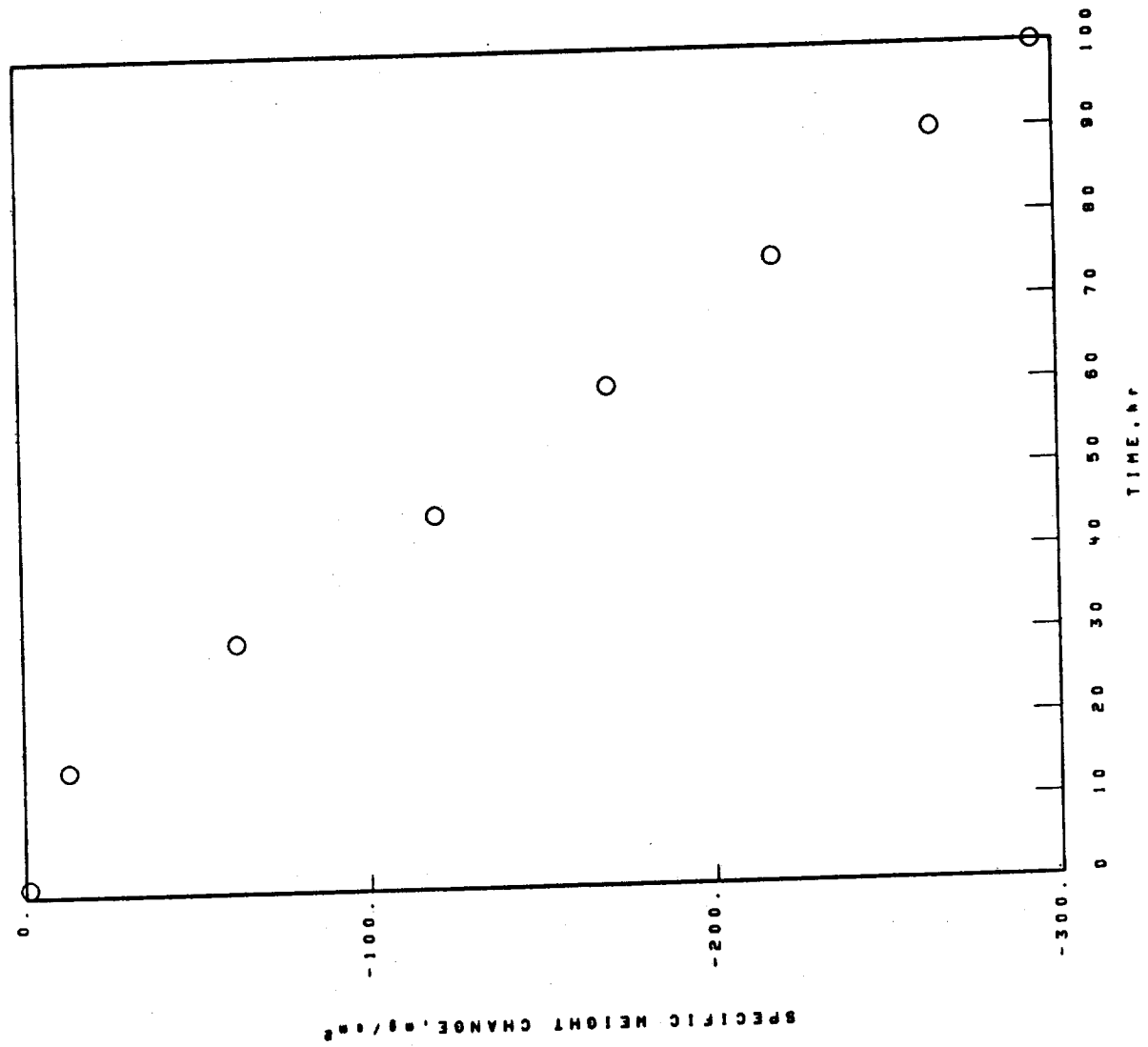
1.00hr CYCLES

1150°C

UDIMET-710

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔM/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	-0.99
15.00	-12.97
30.00	-61.94
45.00	-120.03
60.00	-170.19
75.00	-218.44
90.00	-264.68
100.00	-294.07



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04 023-321-5

UDINET-710

1150°C 1.00hr CYCLES 100.00hr TEST 2-329mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL,  $\theta = 8.30^\circ$

NI<sub>2</sub>O

Cr<sub>2</sub>O<sub>3</sub>

(Ni<sub>2</sub>Co<sub>2</sub>F<sub>2</sub>)TiO<sub>3</sub>

TRI(RUTILE),  $4(110)53.30^\circ$

SPALL

100 hr

COLLECTED SPALL

NI<sub>2</sub>O

SPINEL,  $\theta = 8.25^\circ$

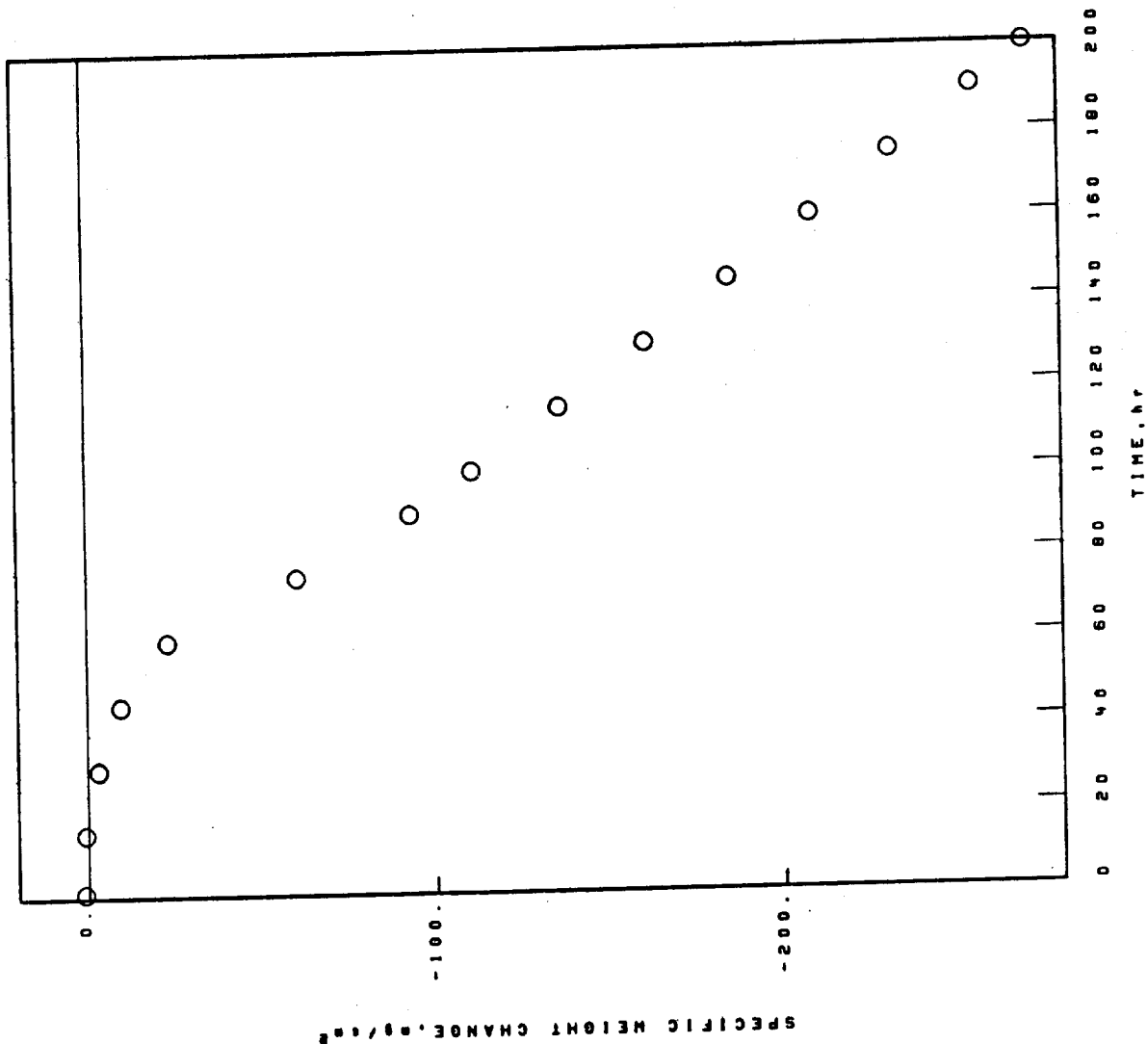
NI(M<sub>2</sub>NO<sub>2</sub>)<sub>2</sub> TYPE 2

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

NI BASE  
 UDIMET-710  
 1100°C  
 1.00hr CYCLES  
 200.00hr TEST  
 2.319mm THICK  
 STATIC AIR  
 02-04 023-324-5

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04 023-324-5  
 UDINET-710 1100°C 1.00hr CYCLES 200.00hr TEST 2.319mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE	SPALL
200 hr	200 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta_0 = 8.30^\circ$	NiO
NiO	SPINEL. $\theta_0 = 8.30^\circ$
Cr <sub>2</sub> O <sub>3</sub>	Cr <sub>2</sub> O <sub>3</sub>
Ni(M.M.)O <sub>4</sub> TYPE 2	(Ni.Co.Fe)TiO <sub>3</sub>
TRI(RUTILE).4(110)53-30A.	

FACE CENTERED CUBIC MATRIX

02-13-020-854-3

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.306mm

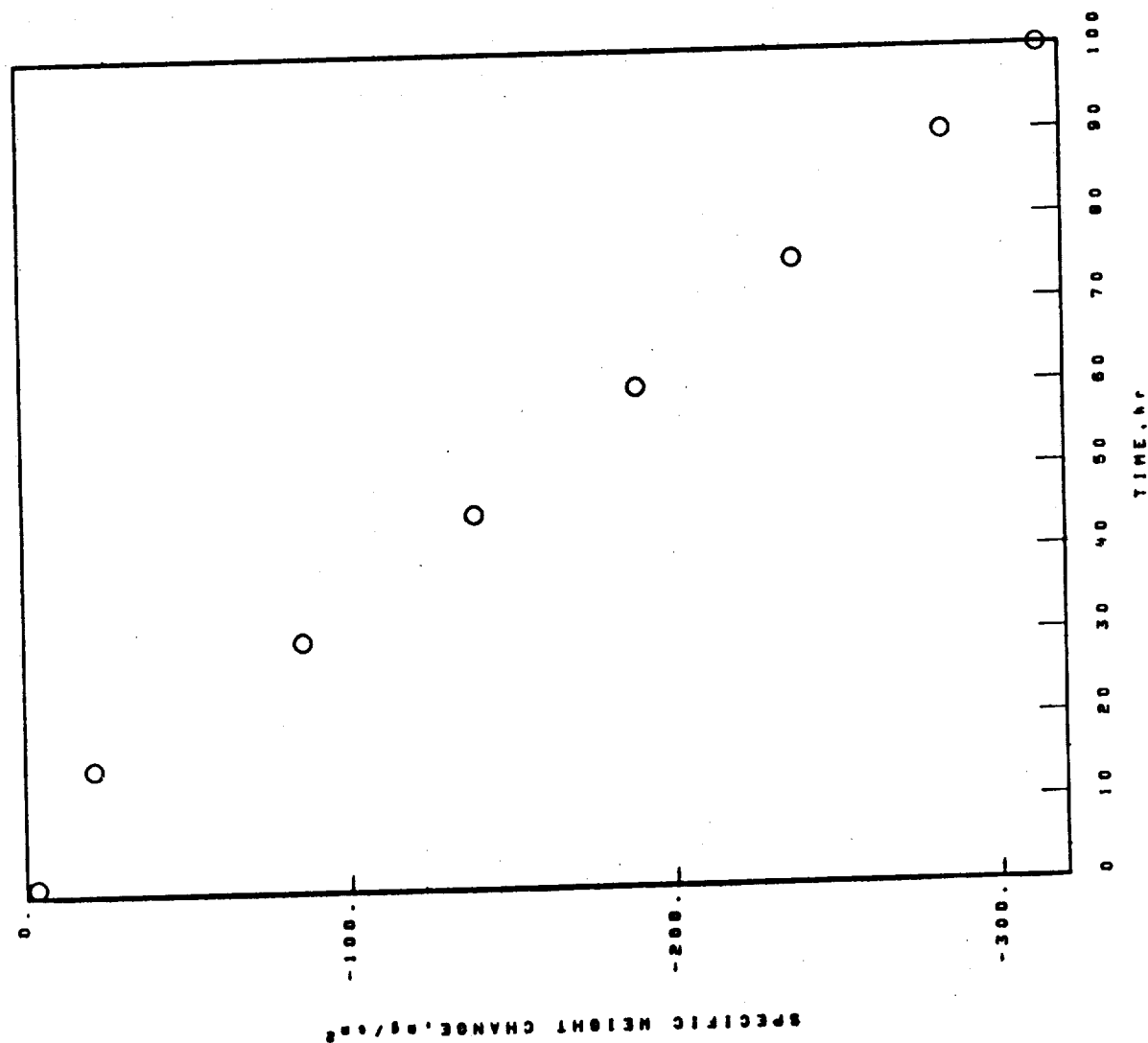
TEST 100.00hr

1150°C

COSAM U-720-14.7C.

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	-3.40
15.00	-21.27
30.00	-85.01
45.00	-138.18
60.00	-188.42
75.00	-237.67
90.00	-293.78
100.00	-313.42



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-020-654-3  
 COSAM U-720-14.7C° 1150°C 1.00hr CYCLES 100.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE SPALL  
 1 hr  
 STANDARD SURFACE COLLECTED SPALL  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).4(110)>3.30A.  
 SPINEL.  $\theta_0=8.25A$ .  
 TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 NiO  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta_0=8.30A$ .  
 (Ni.Co.Fe)TiO<sub>3</sub>  
 Ni(W.Mo)O<sub>4</sub> TYPE 2  
 TRI(RUTILE).4(110)>3.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta_0=8.25A$ .  
 Ni(W.Mo)O<sub>4</sub> TYPE 2

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

200.00hr

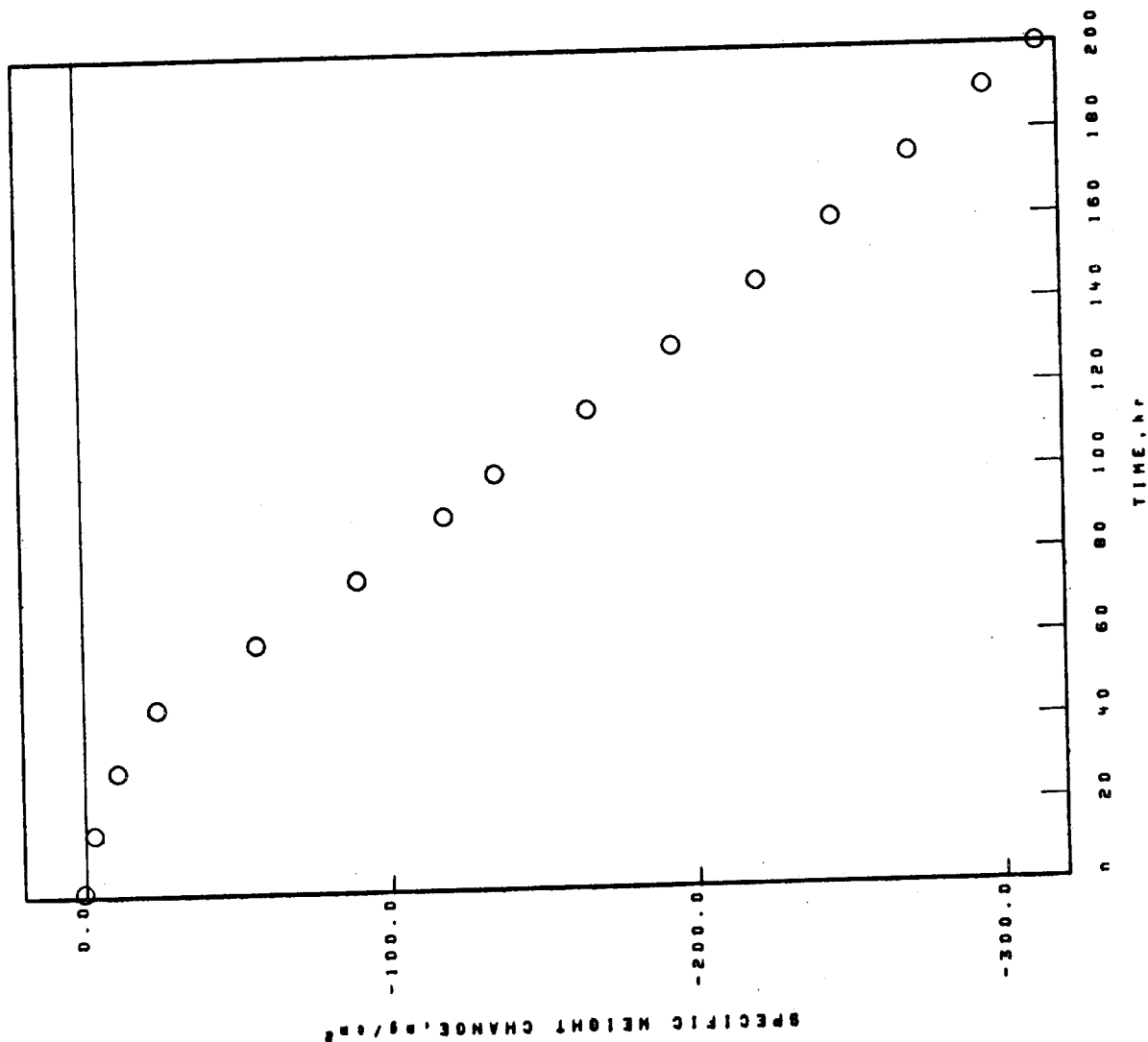
1.00hr

1100°C

COSAM U-720-14.7C.

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	0.57
15.00	-2.92
30.00	-10.74
45.00	-23.80
60.00	-56.48
75.00	-89.71
90.00	-118.42
100.00	-135.17
115.00	-165.53
130.00	-193.42
145.00	-221.31
160.00	-245.98
175.00	-271.45
190.00	-296.03
200.00	-313.46



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-020-655-3  
 COSAM U-720-14.7C. 1100°C 1.00hr CYCLES 200.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 Cr<sub>2</sub>O<sub>3</sub>  
 SPINEL.  $\theta$ -8.25A.  
 TRI(RUTILE).  $\delta$ (110)53.30A.  
 SPALL  
 1 hr  
 COLLECTED SPALL  
 SPINEL.  $\theta$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).  $\delta$ (110)53.30A.

FACE CENTERED CUBIC MATRIX  
 100 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Cr,Fe)TiO<sub>3</sub>  
 TRI(RUTILE).  $\delta$ (110)53.30A.  
 FACE CENTERED CUBIC MATRIX  
 100 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -8.25A.  
 Cr<sub>2</sub>O<sub>3</sub>  
 (Ni,Cr,Fe)TiO<sub>3</sub>  
 SPINEL.  $\theta$ -8.10A.  
 Ni(Mn,Mo)O<sub>4</sub> TYPE 2  
 TRI(RUTILE).  $\delta$ (110)53.30A.

200 hr  
 STANDARD SURFACE  
 NiO  
 SPINEL.  $\theta$ -8.30A.  
 (Ni,Cr,Fe)TiO<sub>3</sub>  
 Cr<sub>2</sub>O<sub>3</sub>  
 TRI(RUTILE).  $\delta$ (110)53.30A.  
 200 hr  
 COLLECTED SPALL  
 NiO  
 SPINEL.  $\theta$ -8.30A.  
 Ni(Mn,Mo)O<sub>4</sub> TYPE 2  
 Cr<sub>2</sub>O<sub>3</sub>

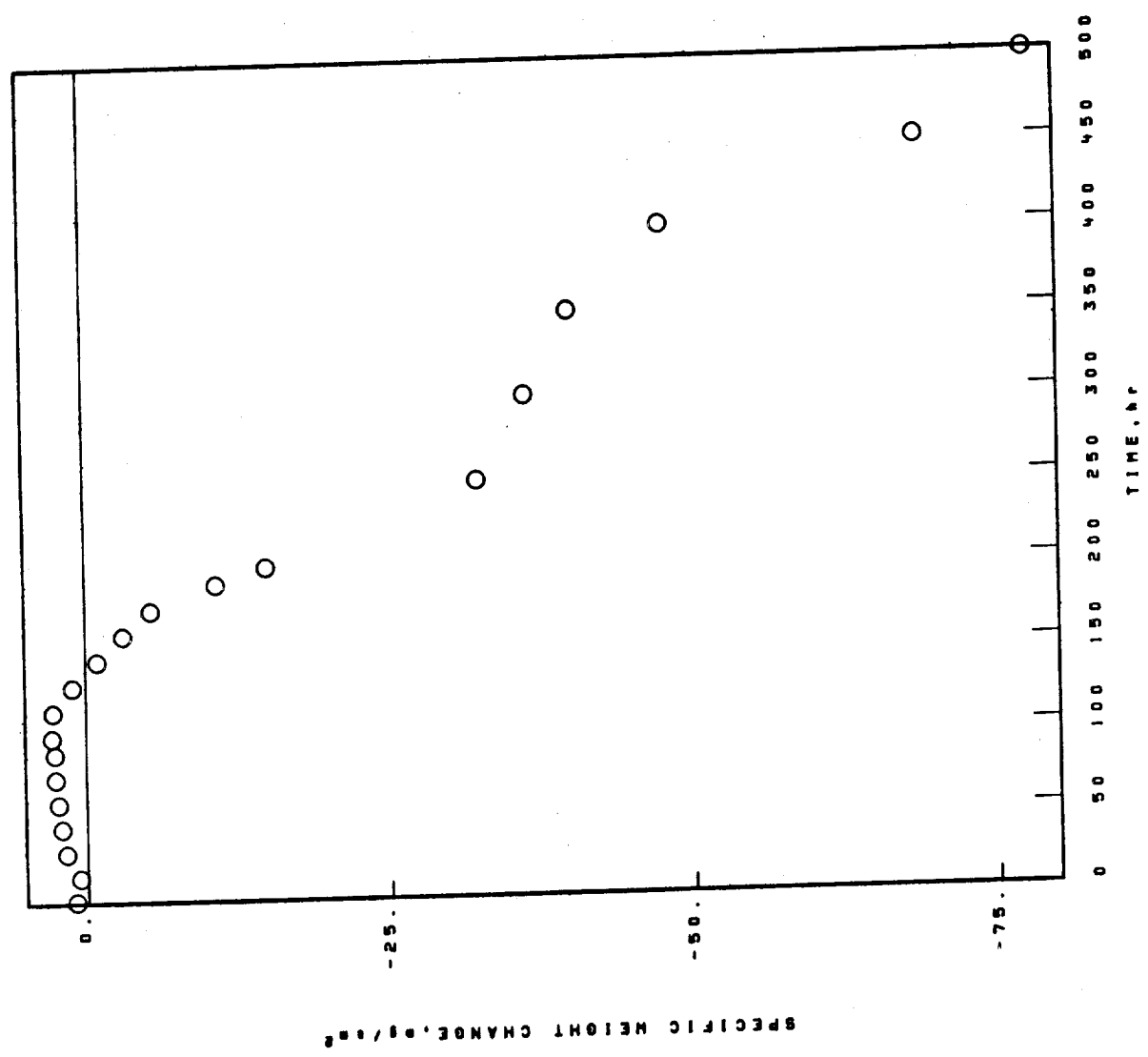
FACE CENTERED CUBIC MATRIX



N1 BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM U-720-14.7C, 1000°C 1.00hr CYCLES 500.00hr TEST 2.377mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	0.93
15.00	0.60
30.00	1.68
45.00	2.05
60.00	2.31
75.00	2.50
90.00	2.58
100.00	2.80
115.00	2.67
130.00	1.05
145.00	-0.98
160.00	-3.13
175.00	-5.44
190.00	-10.78
200.00	-14.98
250.00	-32.38
300.00	-36.39
350.00	-40.81
400.00	-47.61
450.00	-68.60
500.00	-77.59

NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-020-674-8

COSAM U-720-14.7C6

1000°C 1.00hr CYCLES 500.00hr TEST 2.377mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

NI(W.M.)O, TYPE 1

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

.12 Cr-.78 Ti-1.74 O

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

SPINEL. 80-8.35A.

NiO

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

COLLECTED SPALL

NiO

SPINEL. 80-8.35A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

500 hr

500 hr

STANDARD SURFACE

NiO

SPINEL. 80-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

(NI,Cr,F)TiO<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

COLLECTED SPALL

NiO

SPINEL. 80-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

(NI,Cr,F)TiO<sub>3</sub>

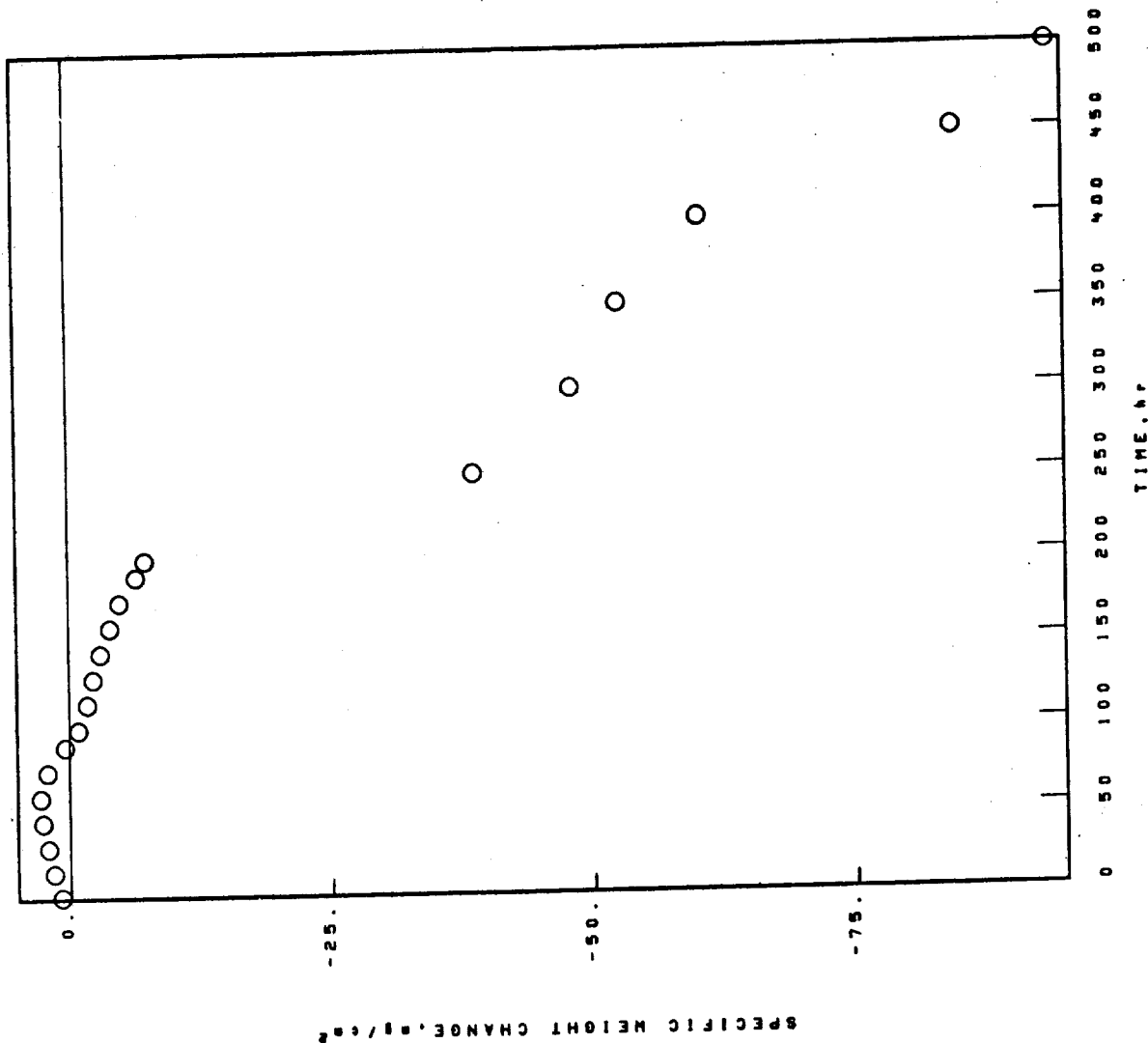
TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM U-720-14.7C° 1000°C 1.00hr CYCLES 500.00hr TEST 2.289mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-020-675-8

COSAM U-720-14.7C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.299mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

SPINEL. a<sub>0</sub>=8.25A.

100 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. a<sub>0</sub>=8.25A.

TRI(RUTILE).d(110)13.30A.

200 hr

COLLECTED SPALL

NiO

SPINEL. a<sub>0</sub>=8.25A.

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

(Ni,Cr,F)TiO<sub>3</sub>

SPINEL. a<sub>0</sub>=8.10A.

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

NiO

(Ni,Cr,F)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. a<sub>0</sub>=8.30A.

500 hr

COLLECTED SPALL

SPINEL. a<sub>0</sub>=8.25A.

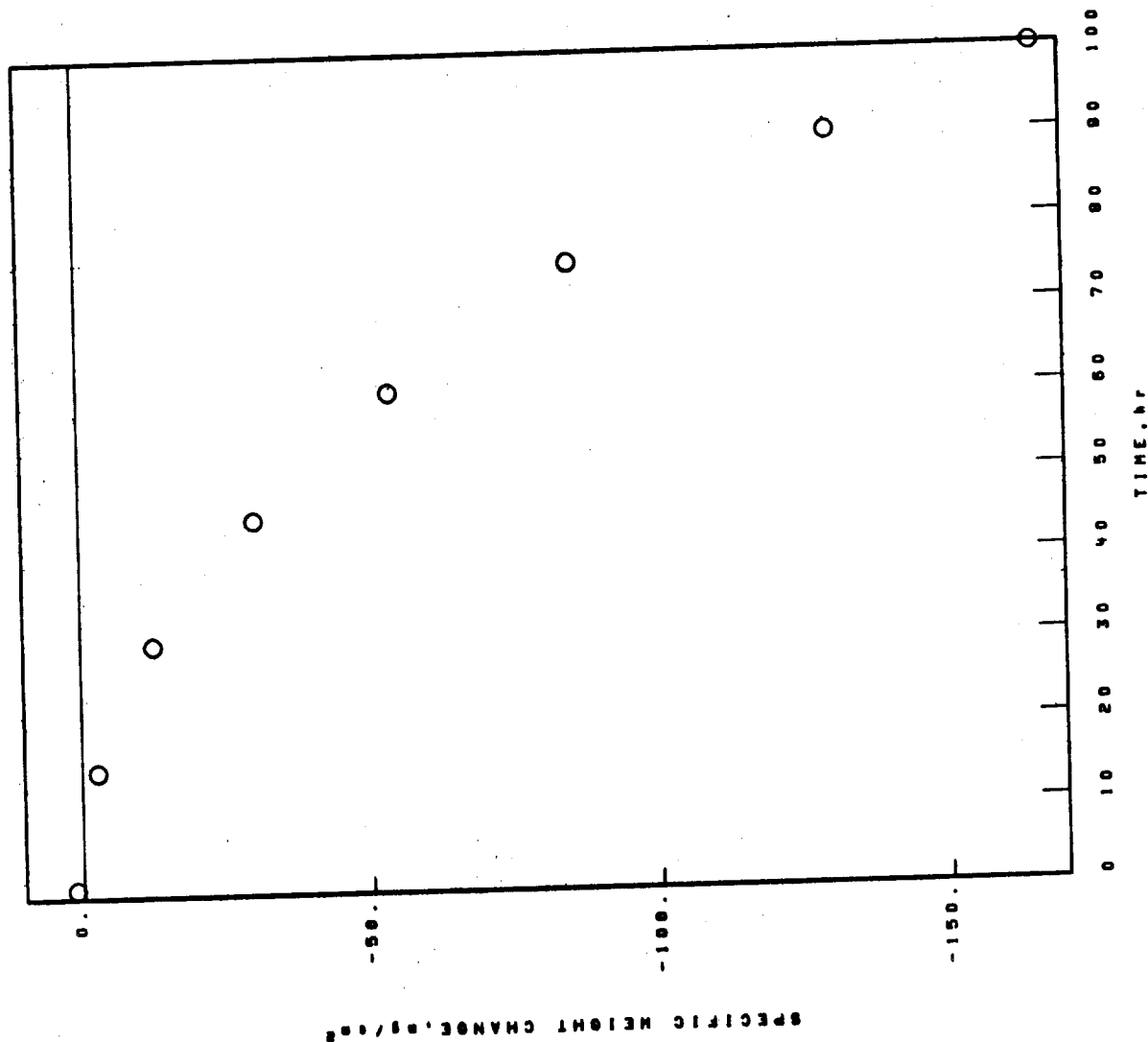
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

NI BASE  
 COSAN WASPALLOY-13-5C  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.282mm THICK  
 STATIC AIR  
 02-13-029-430-6

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	1.22
15.00	-2.63
30.00	-12.60
45.00	-30.20
60.00	-53.04
75.00	-85.03
90.00	-129.04
100.00	-169.20



NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-029-438-6

COSAM HASPALLOY-13.5C.

1150°C 1.00hr CYCLES 100.00hr TEST 2.292mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)>3.30A.

.12 Cr-.78 Ti-1.7% O

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL.  $\theta_0$ =8.30A.

Cr<sub>2</sub>O<sub>3</sub>

Ni(W.M.)O, TYPE 2

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO

SPINEL.  $\theta_0$ =8.30A.

Cr<sub>2</sub>O<sub>3</sub>

Ni(W.M.)O, TYPE 2

02-13-013-470-2

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

100.00hr

1.00hr

CYCLES

1150°C

1150°C

1150°C

1150°C

1150°C

1150°C

1150°C

1150°C

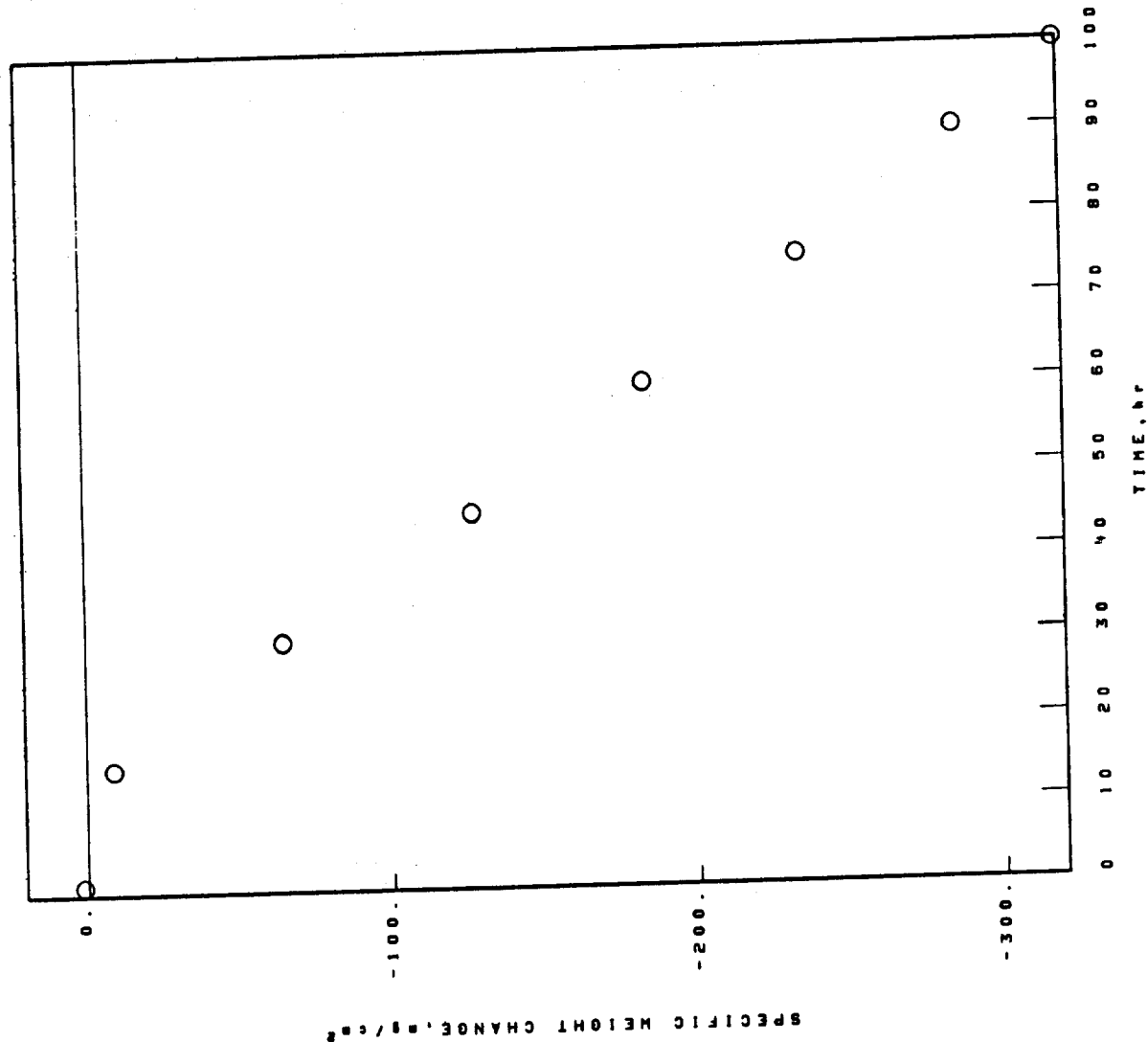
1150°C

1150°C

NASPALLOY

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	1.35
15.00	-8.84
30.00	-64.49
45.00	-127.23
60.00	-183.44
75.00	-234.36
90.00	-285.68
100.00	-318.86



NI BASE  
WASPALLOY

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-013-470-2

1150°C 1.00hr CYCLES 100.00hr TEST 2.290mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

SPINEL. 00-8-10A.

TRICRITILE. 00-118-330A.

NiO

Ni(M.Mo)O, TYPE 1

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

SPINEL. 00-8-30A.

Cr<sub>2</sub>O<sub>3</sub>

Ni(M.Mo)O, TYPE 2

100 hr

COLLECTED SPALL

NiO

SPINEL. 00-8-30A.

Ni(M.Mo)O, TYPE 2

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX



02-13-013-472-1

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

NI BASE

WASPALLOY

STATIC AIR

THICK

TEST

100.00hr

1.00hr

CYCLES

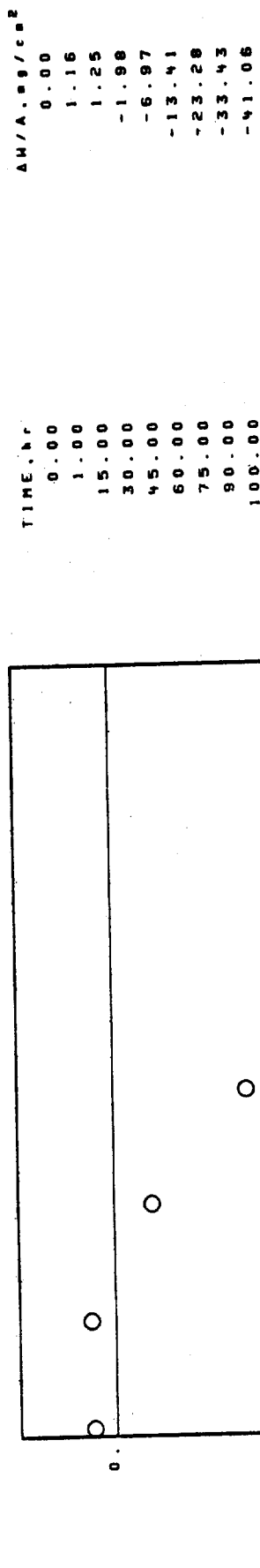
1150°C

100.00hr

TEST

2.284mm

SPECIFIC WEIGHT CHANGE DATA



Ni BASE  
NISPALLOY

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-013-472-1

1150°C 1.00hr CYCLES 100.00hr TEST 2.284mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

SPINEL,  $\theta_0 = 8.35^\circ$

(Ni,Cr,Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

SPALL

1 hr

COLLECTED SPALL

SPINEL,  $\theta_0 = 8.35^\circ$

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

SPINEL,  $\theta_0 = 8.30^\circ$

Cr<sub>2</sub>O<sub>3</sub>

(Ni,Cr)O

100 hr

COLLECTED SPALL

NiO

SPINEL,  $\theta_0 = 8.30^\circ$

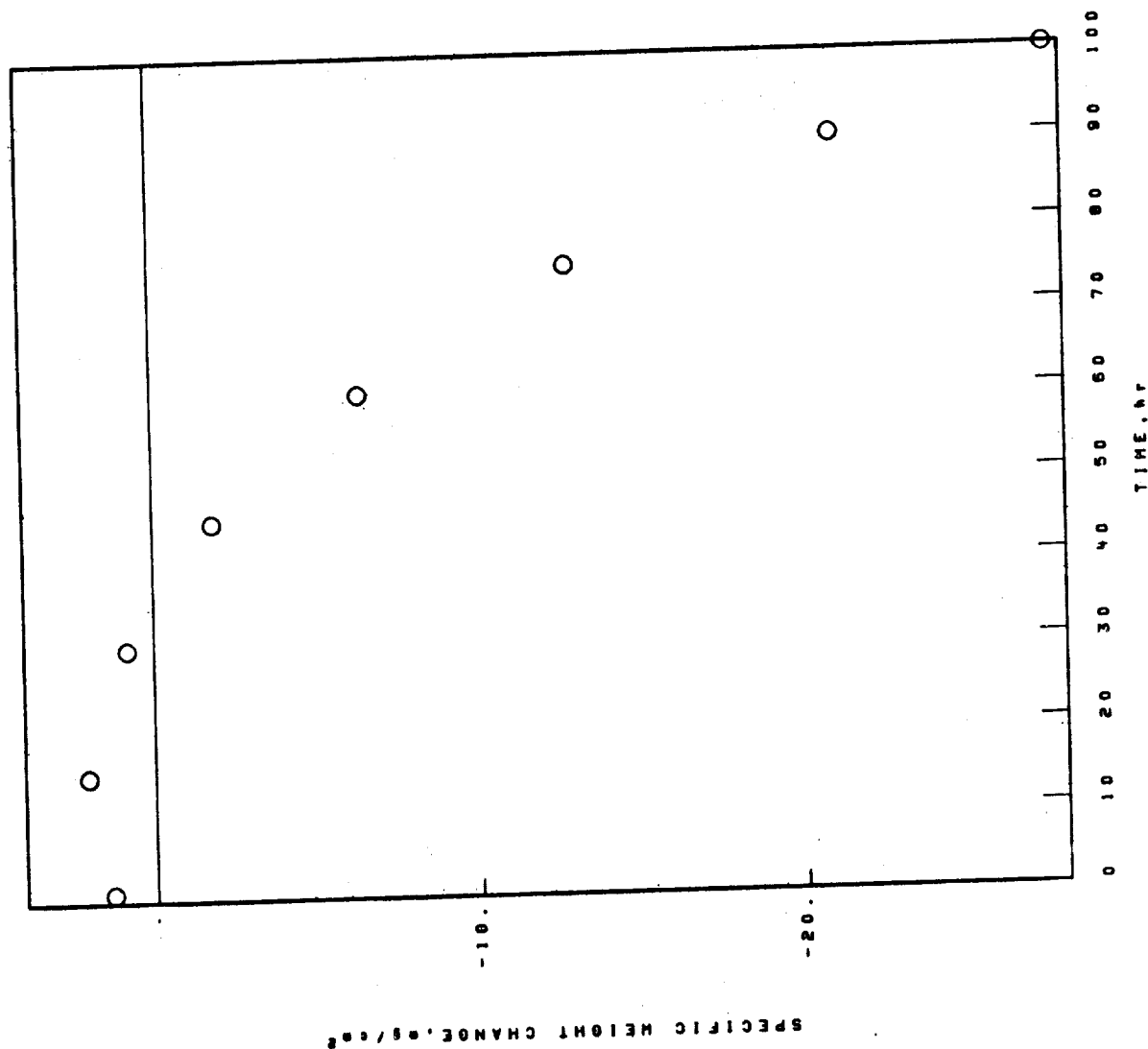
FACE CENTERED CUBIC MATRIX

## NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM HASPALOY-13.5C

1150°C 1.00hr CYCLES 100.00hr TEST 2.309mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, g/cm²
0.00	0.00
1.00	1.32
15.00	2.07
30.00	0.83
45.00	-1.83
60.00	-6.38
75.00	-12.80
90.00	-20.93
100.00	-27.53

NI BASE  
 COSAM WASPALOY-13.5C.  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.309mm THICK  
 STATIC AIR  
 02-13-029-482-8

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

.12 Cr-.78 Ti-1.74 O

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

.12 Cr-.78 Ti-1.74 O

NiO

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

COLLECTED SPALL

NiO

SPIMEL. 90-9.25A.

Cr<sub>2</sub>O<sub>3</sub>

02-13-029-613-5

MI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

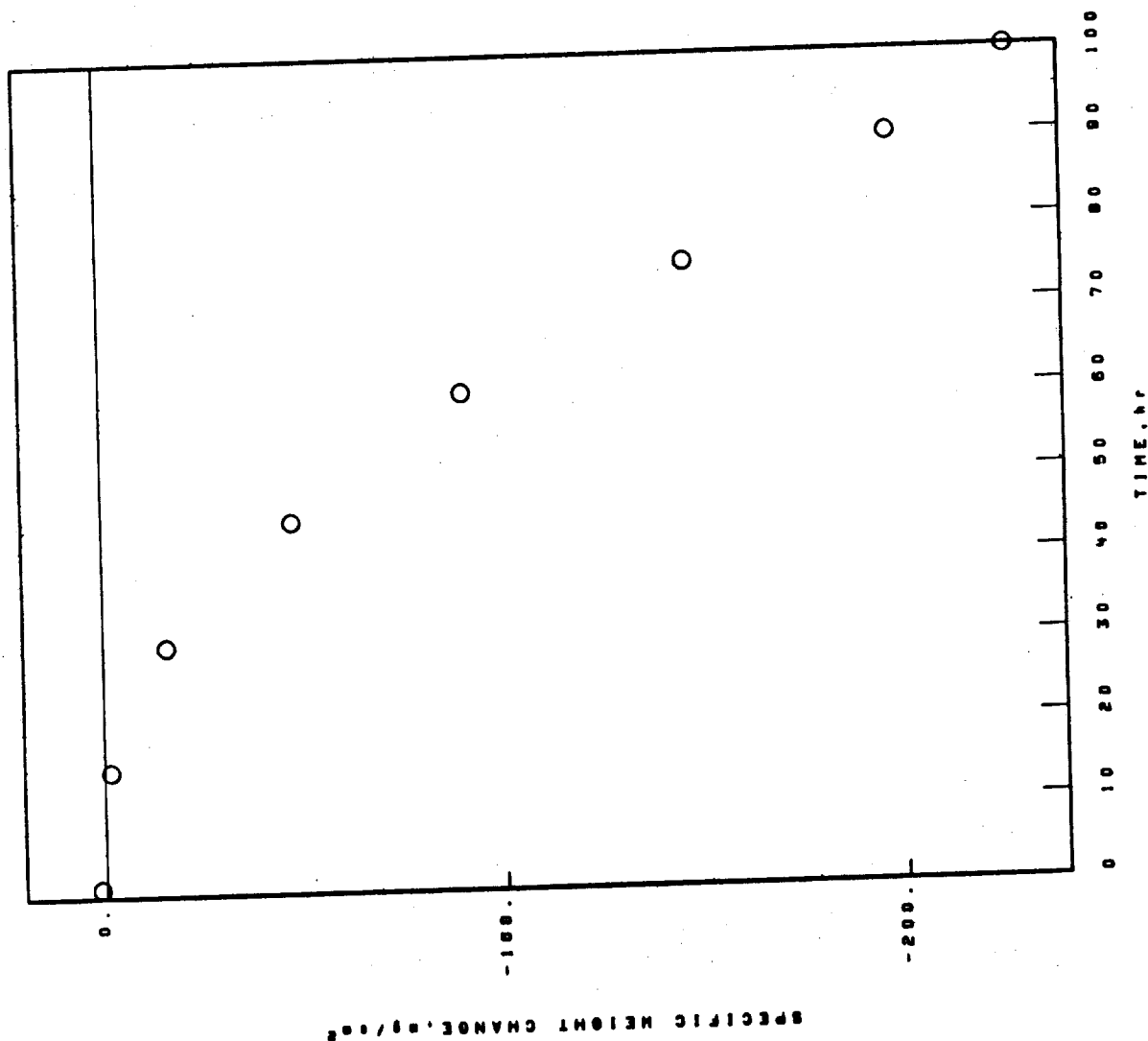
THICK 2.298

TEST 100.00hr

COSAM WASPALOY-13.5C

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	1.30
15.00	-1.48
30.00	-15.82
45.00	-47.47
60.00	-80.42
75.00	-146.08
90.00	-197.07
100.00	-228.73



NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-028-613-S

COSAM WASPALOY-13.5C.

1150°C 1.00hr CYCLES 100.00hr TEST 2.298mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 80-8.25A.

Ni(W.Mo)O, TYPE 2

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

COLLECTED SPALL

NiO

TRI(RUTILE).4(110)13.30A.

SPINEL. 80-8.20A.

100 hr

COLLECTED SPALL

NiO

SPINEL. 80-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

Ni(W.Mo)O, TYPE 2

02-13-013-393-5

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

WASPALLOY

STATIC AIR

THICK

TEST

200.00hr

1.00hr CYCLES

1100°C

2.280mm

TIME, hr

0.00

1.00

15.00

30.00

45.00

60.00

75.00

90.00

100.00

115.00

130.00

145.00

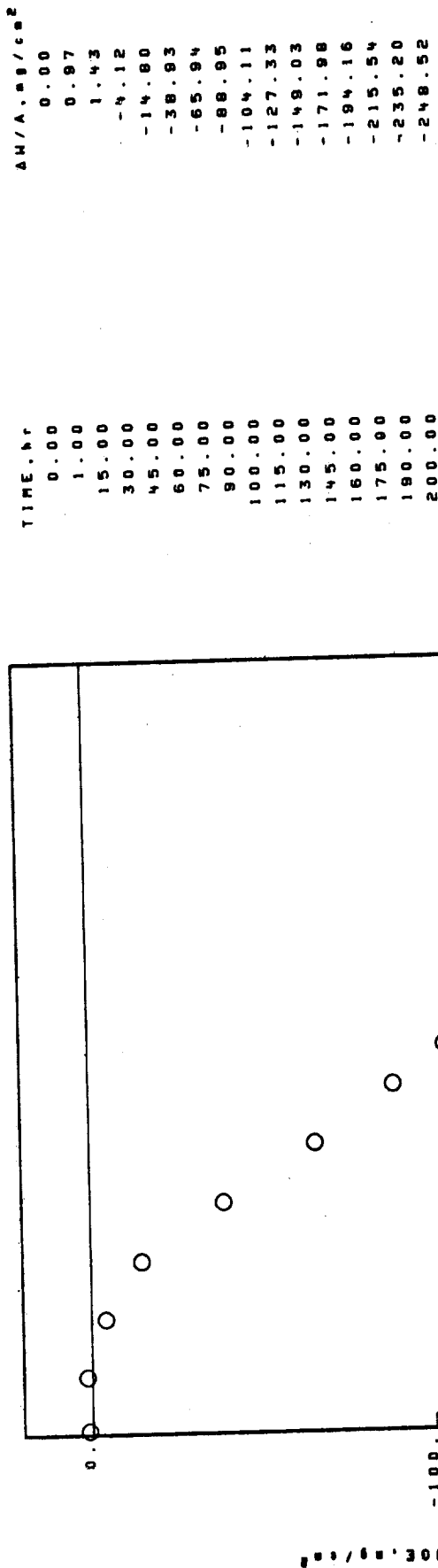
160.00

175.00

190.00

200.00

SPECIFIC WEIGHT CHANGE DATA



NI BASE  
WASPALLOY

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-013-393-5

1100°C

1.00hr CYCLES 200.00hr TEST 2.280mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
200 hr  
STANDARD SURFACE  
NiO  
SPINEL.  $\theta_0$ -8.35A.  
Cr<sub>2</sub>O<sub>3</sub>

SPALL  
200 hr  
COLLECTED SPALL  
NiO  
SPINEL.  $\theta_0$ -8.30A.  
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

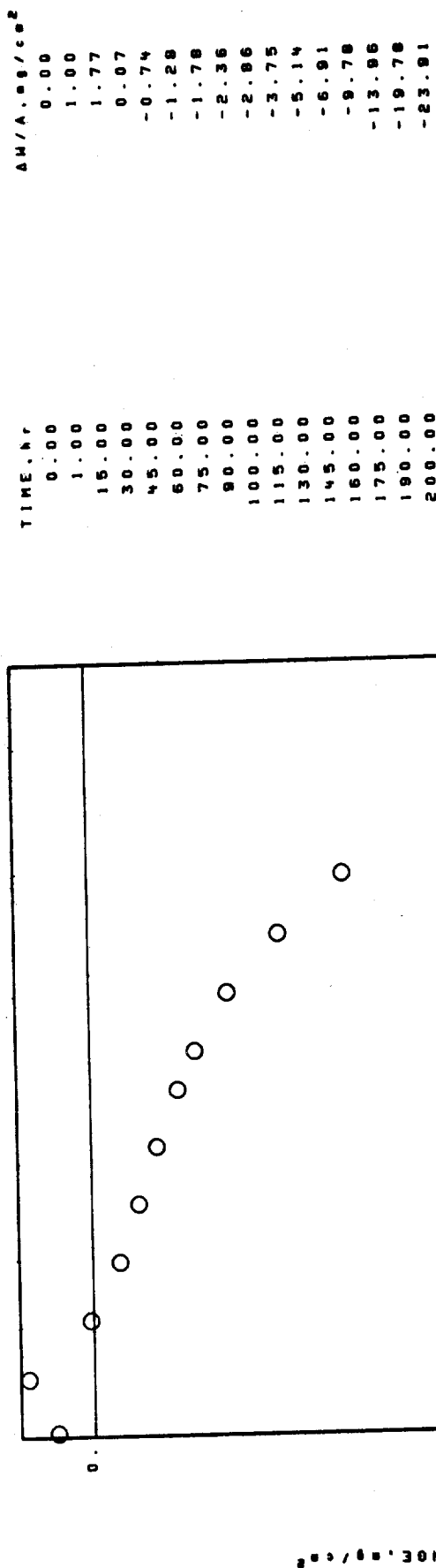
STATIC AIR

THICK 2.320mm TEST 200.00hr

1100°C 1.00hr CYCLES 200.00hr TEST 2.320mm THICK STATIC AIR

COSAM WASPALOY-13.5C.

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL NOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-029-437-8

COSAM WASPALOY-13.5C.

1100°C 1.00hr CYCLES 200.00hr TEST 2.320mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

UNKNOWN LINES. d VALUES

3.17A.

3.31A.

3.08A.

100 hr

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

NI<sub>2</sub>O

SPINEL. d<sub>0</sub>-8.30A.

UNKNOWN LINES. d VALUES

3.15A.

3.31A.

3.07A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).d(110)13.30A.

NI<sub>2</sub>O

200 hr

PROBABLE CROSS-SPALL

NI<sub>2</sub>O

SPINEL. d<sub>0</sub>-8.35A.

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

02-13-013-473-1

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

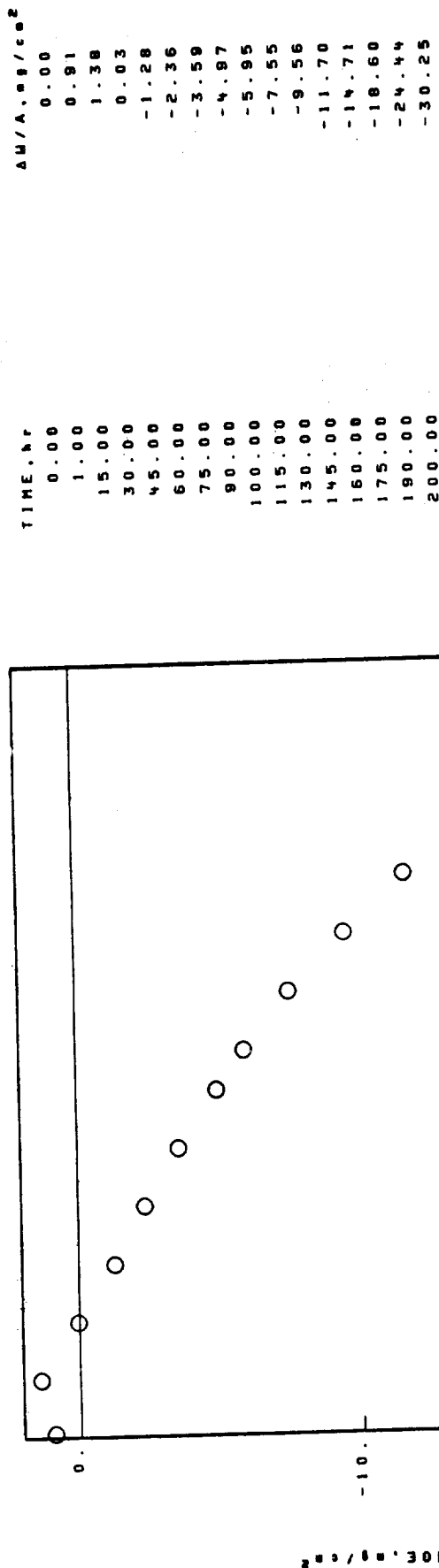
2.304mm THICK

TEST

1100°C 1.00hr CYCLES 200.00hr

WASPALLOY

SPECIFIC WEIGHT CHANGE DATA



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-013-473-1  
 HASPALOY 1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
1 hr

SPALL  
1 hr

STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>

NO SIGNIFICANT SPALL OBSERVED

TRI(RUTILE), 4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr  
STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>

100 hr  
COLLECTED SPALL  
NiO  
SPINEL,  $\theta_0 = 0.25A$ .  
Cr<sub>2</sub>O<sub>3</sub>  
ZrO<sub>2</sub>  
Ni(M.NiO), TYPE 2

FACE CENTERED CUBIC MATRIX

200 hr  
STANDARD SURFACE  
Cr<sub>2</sub>O<sub>3</sub>  
NiO

TRI(RUTILE), 4(110)13.30A.  
SPINEL,  $\theta_0 = 0.25A$ .

200 hr  
COLLECTED SPALL  
NiO  
SPINEL,  $\theta_0 = 0.25A$ .  
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

## N1 BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

2.300mm

TEST

200.00hr

1.00hr

CYCLES

1100°C

1100°C

1100°C

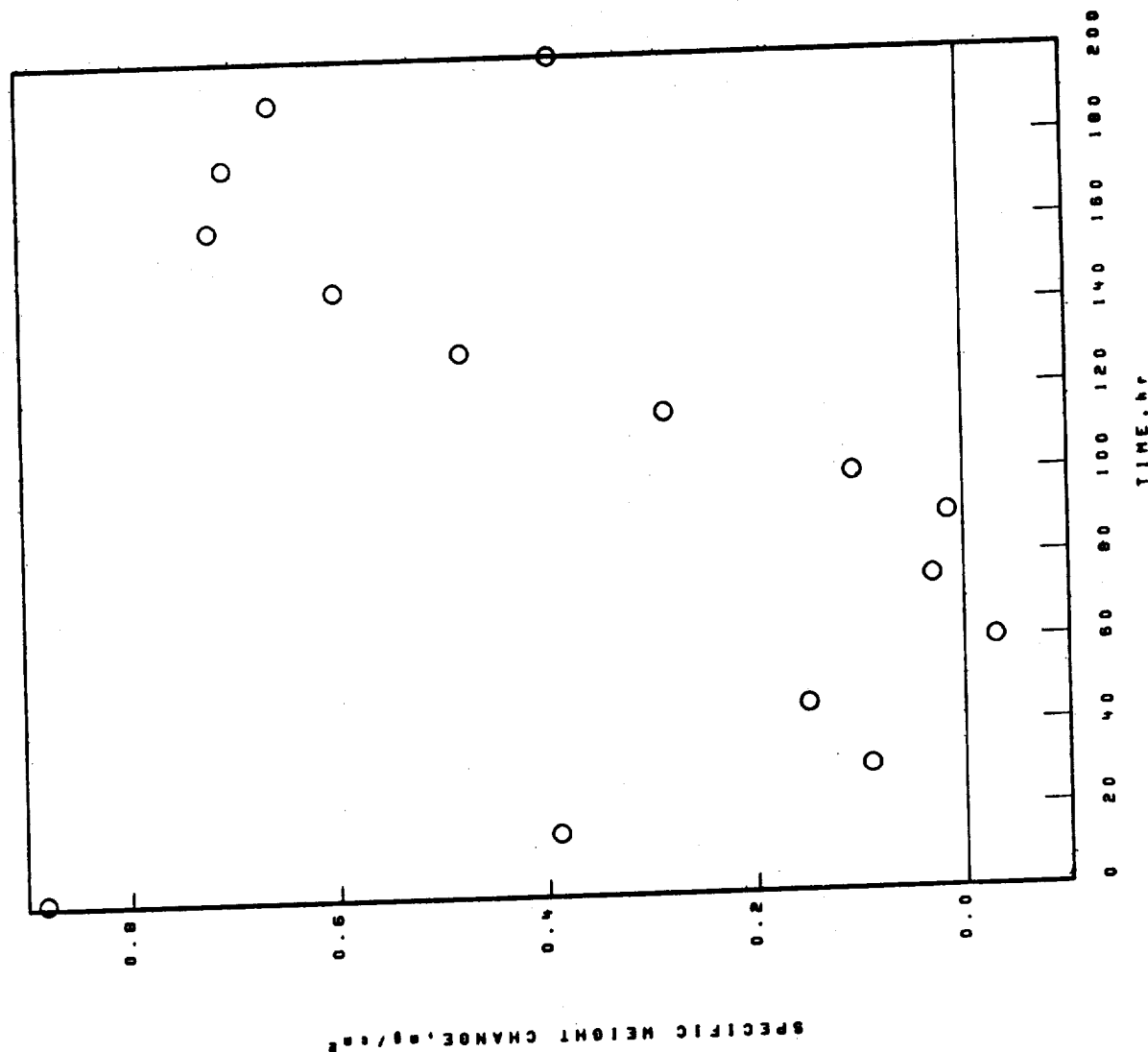
1100°C

1100°C

1100°C

COSAM HASPALLOY-13.5C.

## SPECIFIC WEIGHT CHANGE DATA



NI BASE  
 COSAM WASPALOY-13.5C  
 COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.300mm THICK STATIC AIR  
 02-13-029-481-6

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

.12 Cr-.78 Ti-1.74 O

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

.12 Cr-.78 Ti-1.74 O

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

WIO

TRI(RUTILE).4(110)13.30A.

SPINEL. 10-8-35A.

.12 Cr-.78 Ti-1.74 O

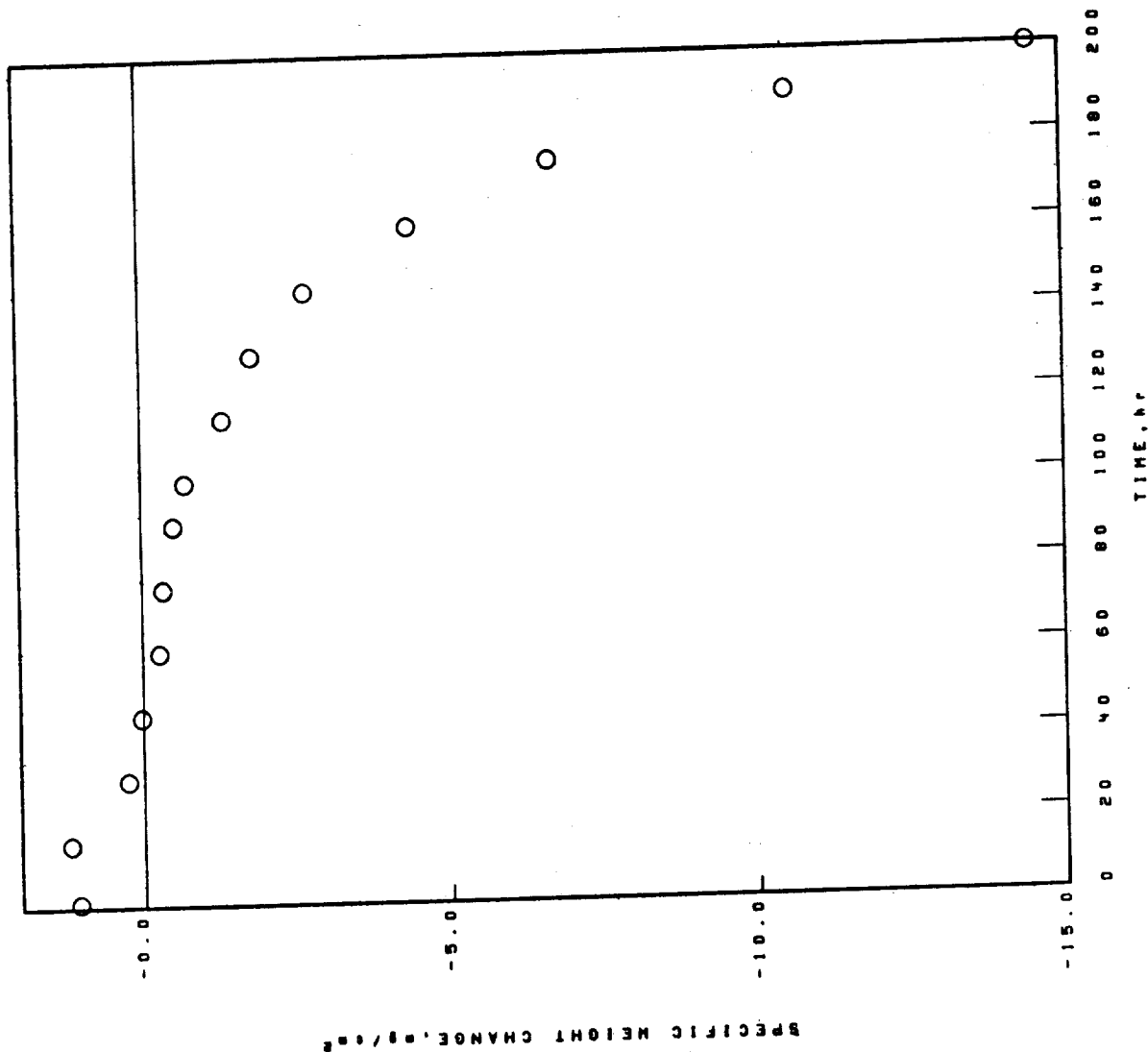
Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

MI BASE

COSAM WASPALOY-13.5C.

COSAM WASPALOY-13.5C.



TIME, hr	$\Delta H/A, \text{mJ/cm}^2$
0.00	0.00
1.00	1.07
15.00	1.20
30.00	0.26
45.00	0.03
60.00	-0.27
75.00	-0.35
90.00	-0.53
100.00	-0.72
115.00	-1.34
130.00	-1.82
145.00	-2.70
160.00	-4.40
175.00	-6.71
190.00	-10.56
200.00	-14.48

NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-029-614-5

COSAM WASPALLOY-13.5C.

1100°C 1.00hr CYCLES 200.00hr TEST 2.285mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)>3.30A.

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

.12 Cr-.78 Ti-1.74 O

FACE CENTERED CUBIC MATRIX

100 hr

PROBABLE CROSS-SPALL

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.25A.

TRI(RUTILE).4(110)>3.30A.

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 90-8.25A.

FACE CENTERED CUBIC MATRIX

200 hr

COLLECTED SPALL

NiO

SPINEL. 90-8.25A.

UNKNOWN LINES. 4 VALUES

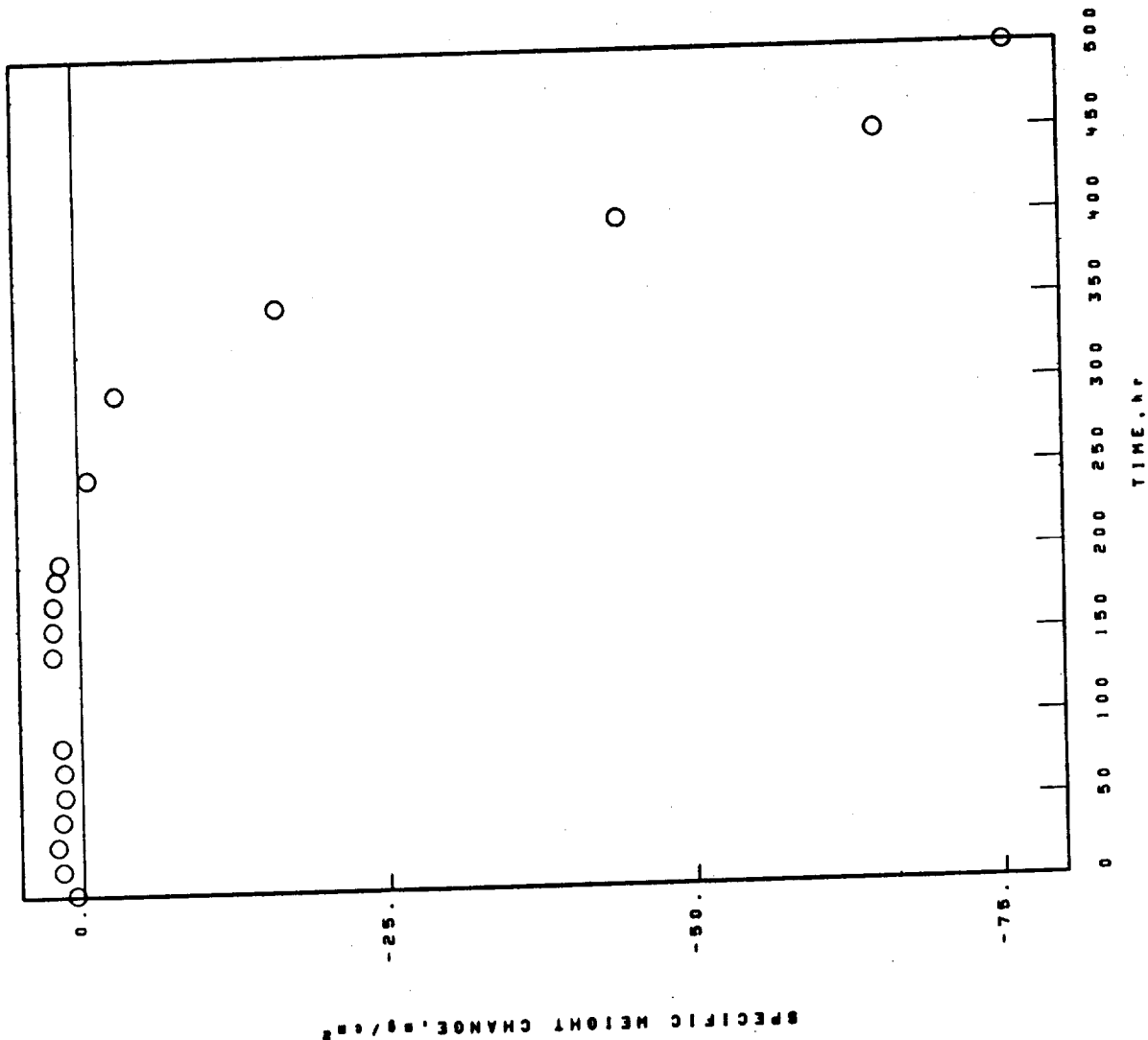
2.82A.



NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

COSAM HASPALLOY-13.5C. 1000°C 1.00hr CYCLES 500.00hr TEST 2.322mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE

COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

02-13-029-436-6

COSAM WASPALOY-13.5C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.322mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

SPALL

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)53.30A.

FACE CENTERED CUBIC MATRIX

200 hr

COLLECTED SPALL

NiO

Cr<sub>2</sub>O<sub>3</sub>

SPINEL. 40-8.30A.

TRI(RUTILE).4(110)53.30A.

500 hr

STANDARD SURFACE

NiO

SPINEL. 40-8.25A.

Cr<sub>2</sub>O<sub>3</sub>

(Ni.Co.Fe)TiO<sub>3</sub>

500 hr

COLLECTED SPALL

NiO

SPINEL. 40-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK

TEST

500.00hr

1000°C

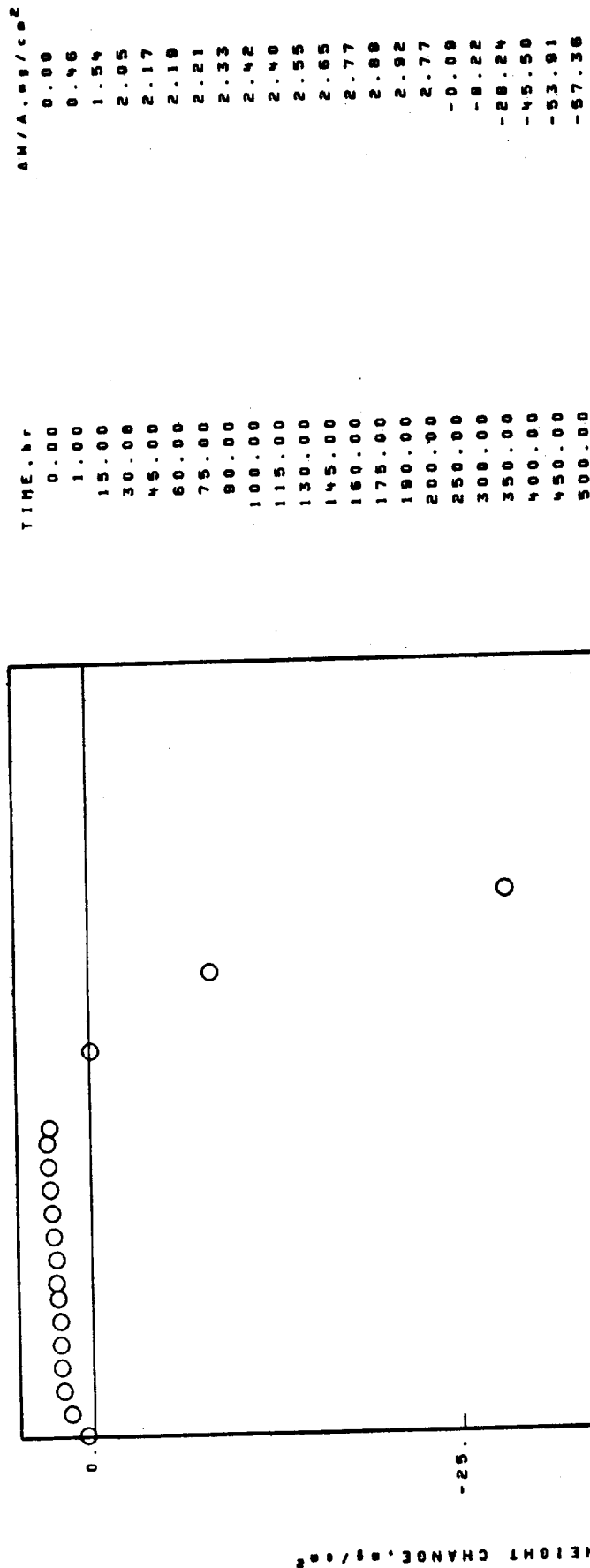
1.00hr

CYCLES

13.5C

COSAM WASPALOY-13.5C

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS                      02-13-028-480-6  
 COSAM WASPALOY-13.5C                      1000°C                      1.00hr CYCLES                      580.00hr TEST                      2.327mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE  
   1 hr  
 STANDARD SURFACE  
   Cr<sub>2</sub>O<sub>3</sub>  
   TRI(RUTILE).4(110)>3.30A.  
 SPALL  
   1 hr  
 NO SIGNIFICANT SPALL OBSERVED

FACE CENTERED CUBIC MATRIX  
 100 hr  
 STANDARD SURFACE  
   Cr<sub>2</sub>O<sub>3</sub>  
   TRI(RUTILE).4(110)>3.30A.  
 COLLECTED SPALL  
   Cr<sub>2</sub>O<sub>3</sub>  
   TRI(RUTILE).4(110)>3.30A.  
   NiO

FACE CENTERED CUBIC MATRIX  
 200 hr  
 STANDARD SURFACE  
   Cr<sub>2</sub>O<sub>3</sub>  
   SPINEL. 8.8-8.30A.  
   TRI(RUTILE).4(110)>3.30A.  
   ZrO<sub>2</sub>  
 COLLECTED SPALL  
   NiO  
   Cr<sub>2</sub>O<sub>3</sub>  
   SPINEL. 8.8-8.30A.

FACE CENTERED CUBIC MATRIX

02-09-105-615-5

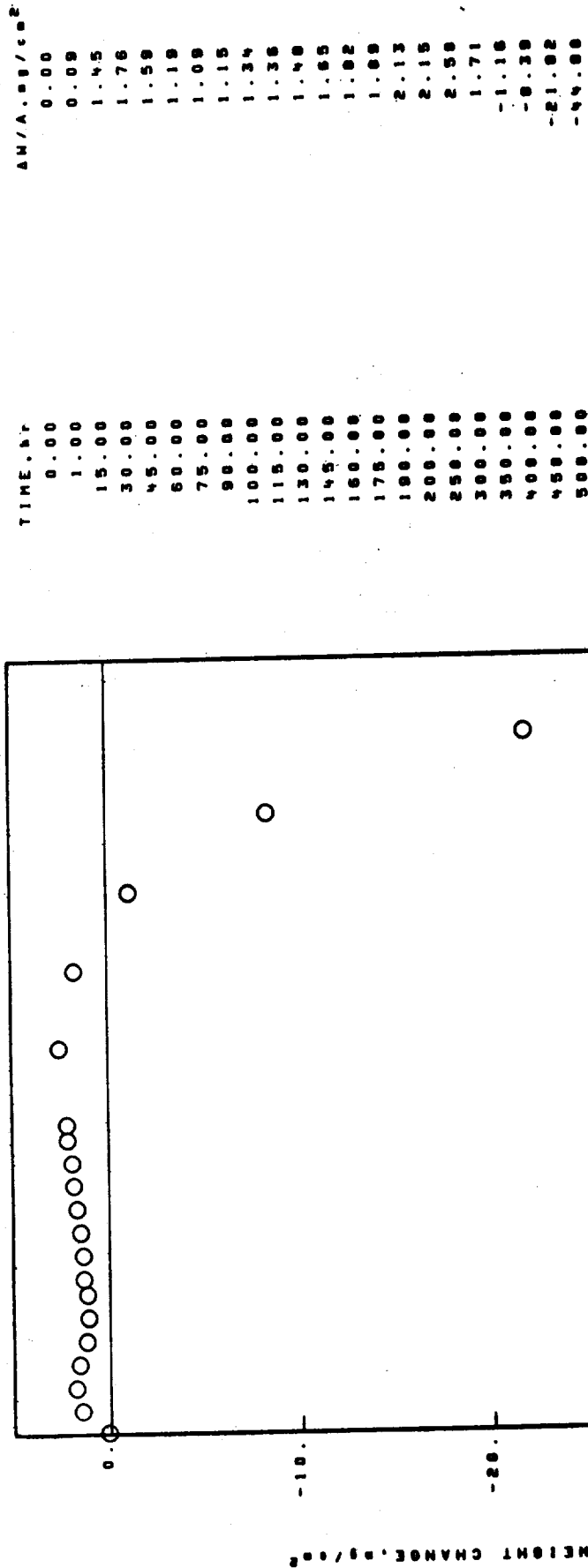
NI BASE EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

COSAM WASPALOY-13.5C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.318mm THICK

STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



NI BASE

EXPERIMENTAL CAST GAMMA/GAMMA PRIME ALLOYS

02-09-105-615-5

COSAH WASPALLOY-13.5C.

1000°C 1.00hr CYCLES 500.00hr TEST 2.318mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

SPALL

1 hr

1 hr

STANDARD SURFACE

NO SIGNIFICANT SPALL OBSERVED

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE). d(110) 3.30A.

FACE CENTERED CUBIC MATRIX

100 hr

100 hr

STANDARD SURFACE

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

NiO

FACE CENTERED CUBIC MATRIX

200 hr

200 hr

STANDARD SURFACE

COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

NiO

SPINEL. d<sub>0-0.25A.</sub>

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

500 hr

500 hr

STANDARD SURFACE

COLLECTED SPALL

NiO

NiO

SPINEL. d<sub>0-0.25A.</sub>

SPINEL. d<sub>0-0.25A.</sub>

(Ni,Cr,Fe)TiO<sub>3</sub>

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

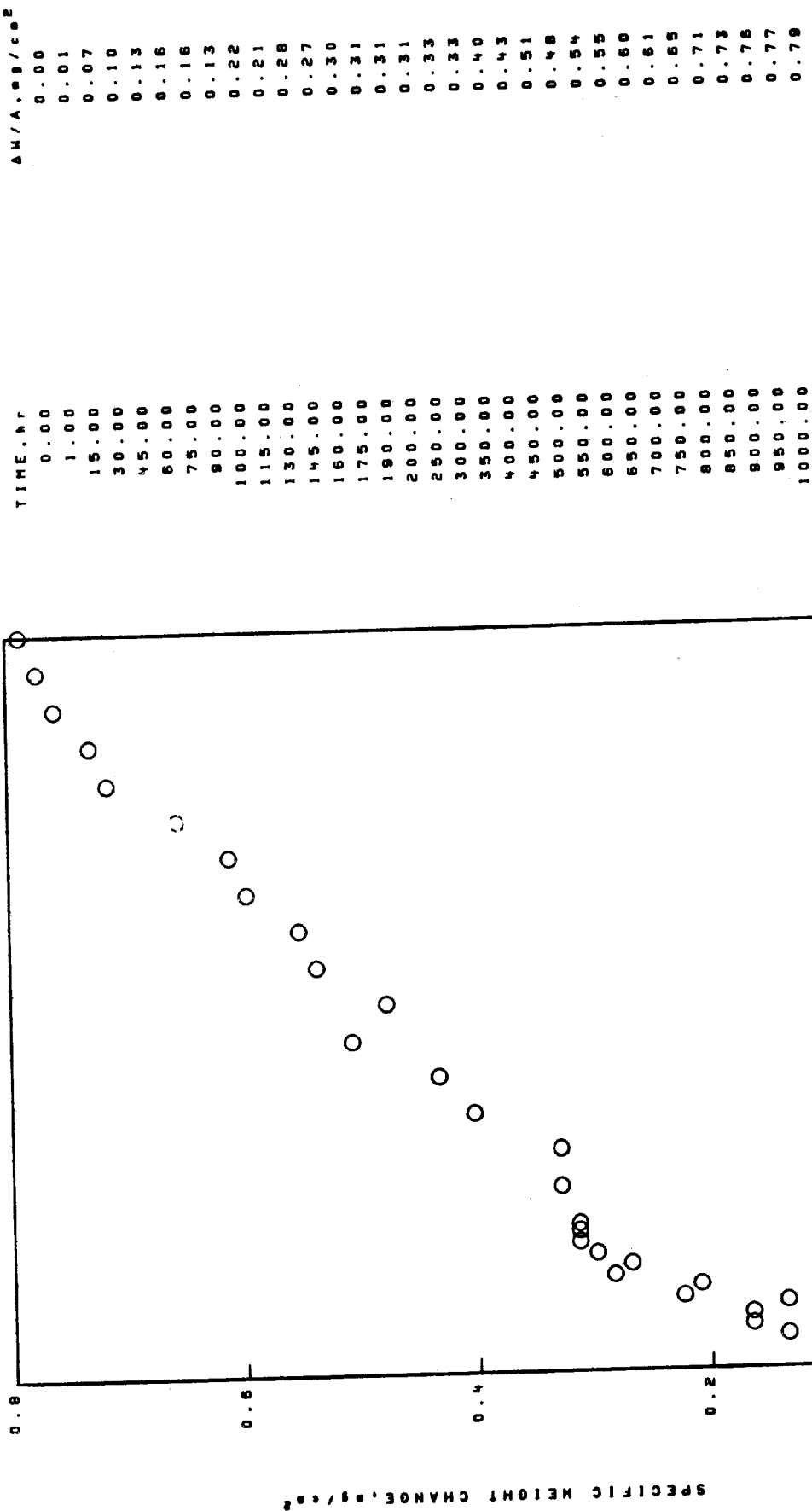
NI BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

760°C 1.00hr CYCLES 1000.00hr TEST 2.306mm THICK

COSAM WASPALLOY-13.5C

SPECIFIC WEIGHT CHANGE DATA



NI BASE                      COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS                      02-13-029-439-6  
 COSAM WASPALOY-13.5C<sub>a</sub>                      750°C                      1.00hr CYCLES                      1000.00hr TEST                      2.306mm THICK                      STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

1 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

FACE CENTERED CUBIC MATRIX

100 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

200 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

500 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

1000 hr

STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>

TRI(RUTILE).4(110)13.30A.

FACE CENTERED CUBIC MATRIX

SPALL

1 hr

COLLECTED SPALL

SPINEL. 40-8.30A.

Cr<sub>2</sub>O<sub>3</sub>

NiO

100 hr

PROBABLE CROSS-SPALL

NiO

200 hr  
NO SIGNIFICANT SPALL OBSERVED

500 hr  
COLLECTED SPALL  
NiO

1000 hr  
COLLECTED SPALL  
SPINEL. 40-8.25A.



02-04-041-414-5

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

NI BASE

STATIC AIR

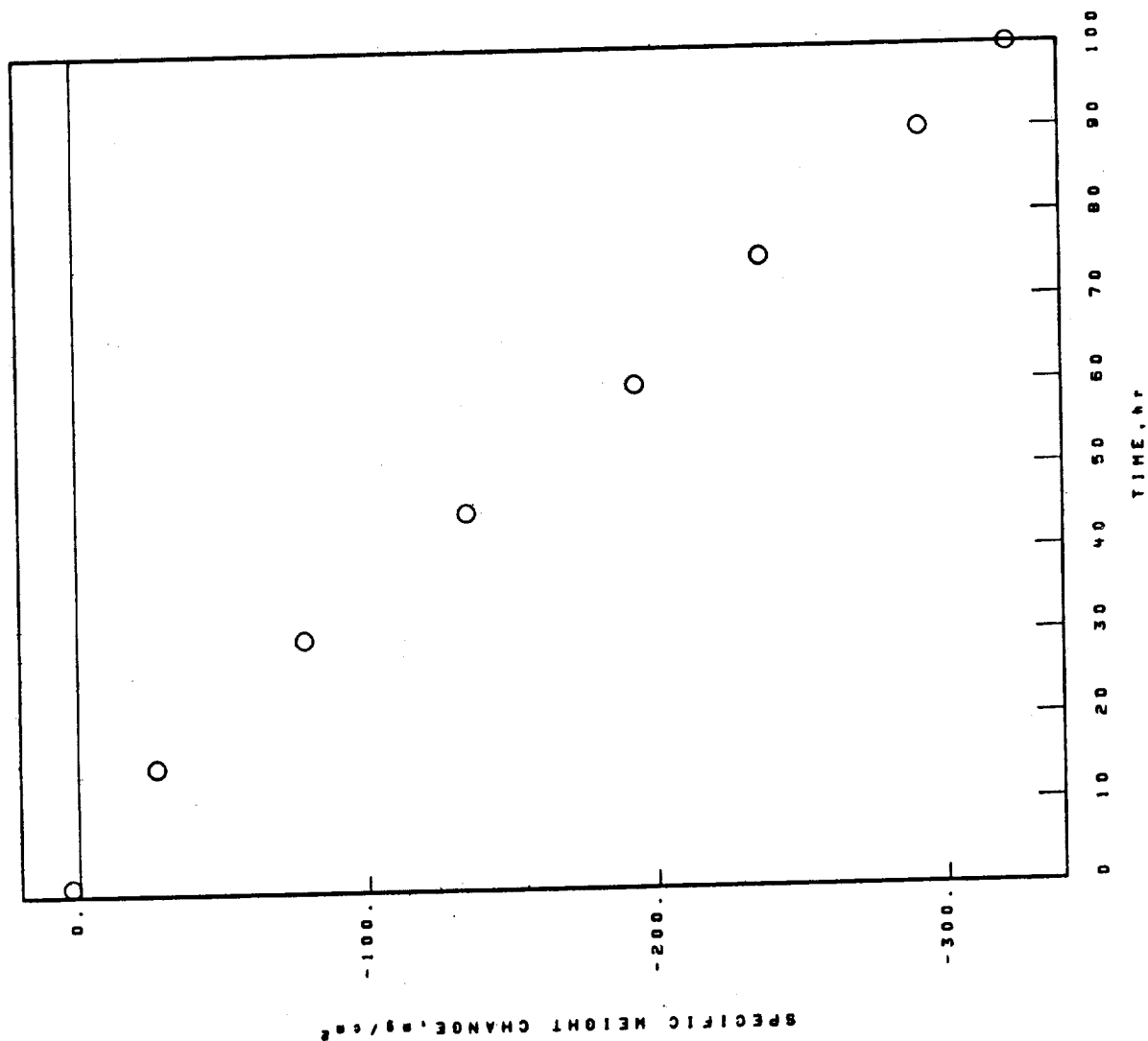
THICK 2.326mm

1150°C 1.00hr CYCLES 100.00hr TEST

DS-WAZ-20

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, \text{mg/cm}^2$
0.00	0.00
1.00	2.59
15.00	-27.06
30.00	-78.35
45.00	-134.83
60.00	-193.38
75.00	-236.76
90.00	-291.99
100.00	-322.49



NI BASE  
 DS-WAZ-20  
 COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS  
 1150°C  
 1.00hr CYCLES  
 100.00hr TEST  
 2.326mm THICK  
 STATIC AIR  
 02-04-041-414-S

X-RAY DIFFRACTION DATA

SURFACE  
 100 hr  
 STANDARD SURFACE  
 NiO  
 Ni(M.M.)O<sub>2</sub> TYPE I

SPALL  
 100 hr  
 PROBABLE CROSS-SPALL  
 NiO  
 Ni(M.M.)O<sub>2</sub> TYPE I  
 SPINEL. 80-8.25A.

02-04-041-413-5

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

STATIC AIR

THICK 2.324mm TEST 200.00hr

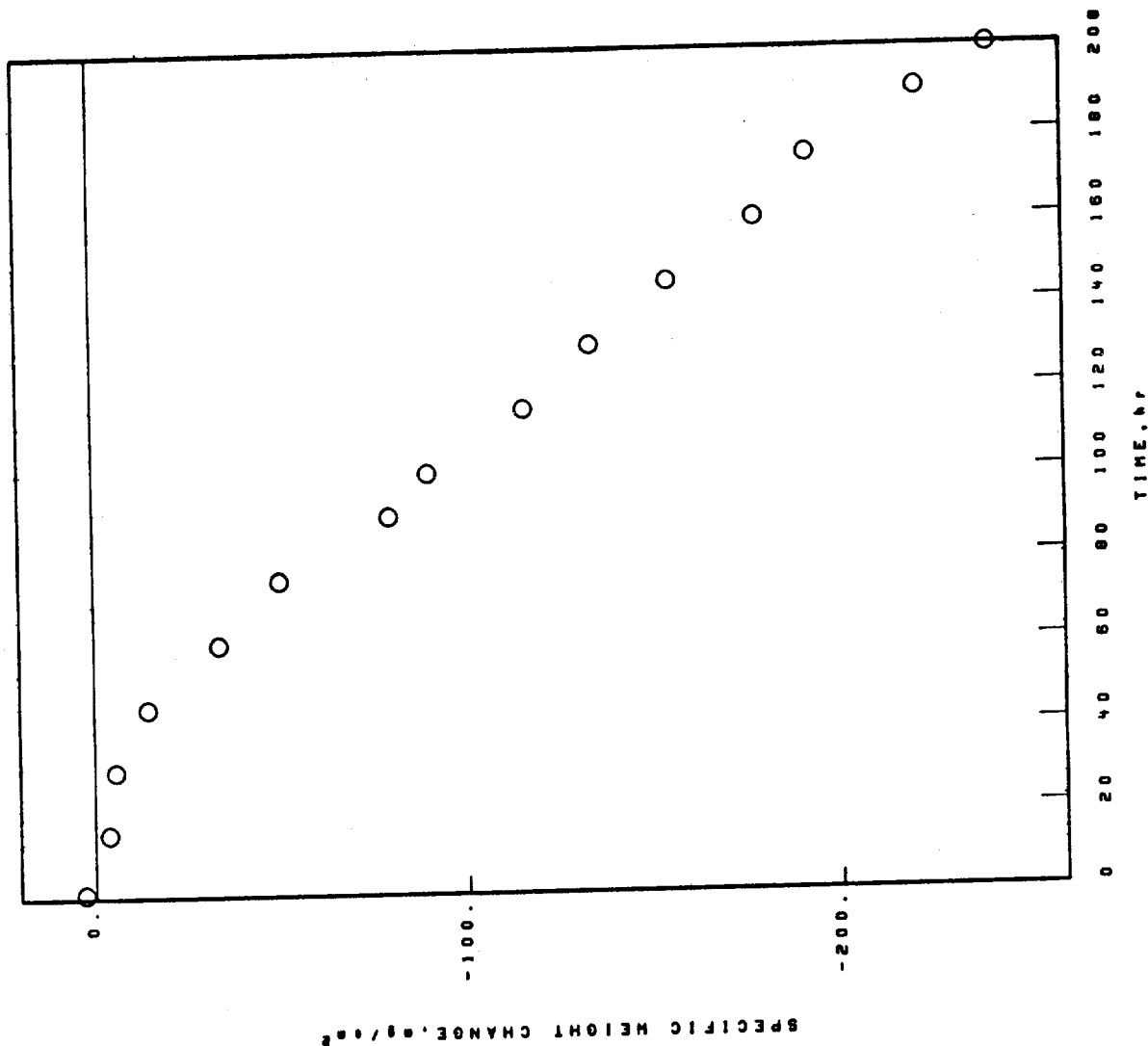
1100°C 1.00hr CYCLES

DS-WAZ-20

NI BASE

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, mg/cm <sup>2</sup>
0.00	0.00
1.00	2.69
15.00	-3.75
30.00	-5.55
45.00	-14.36
60.00	-33.49
75.00	-49.88
90.00	-79.43
100.00	-89.94
115.00	-115.89
130.00	-133.66
145.00	-154.62
160.00	-177.99
175.00	-191.92
190.00	-221.28
200.00	-240.60



NI BASE

COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS

02-04-041-413-5

DS-WAZ-20

1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

NIO

NI(W.M.)O<sub>4</sub> TYPE 1

SPINEL. 90-8.05A.

SPALL

200 hr

COLLECTED SPALL

NIO

NI(W.M.)O<sub>4</sub> TYPE 1

FACE CENTERED CUBIC MATRIX

UNKNOWN LINES. d VALUES

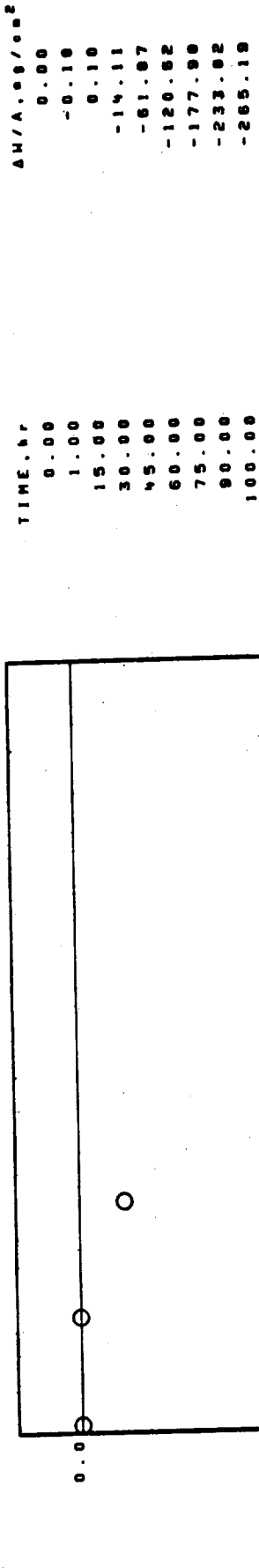
3.64A.

C. BASE CAST (TURBINE) ALLOYS

1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

MAR-M-509

SPECIFIC WEIGHT CHANGE DATA



C. BASE

CAST (TURBINE) ALLOYS

MAR-M-509

03 02-003-323-4

1150°C

1.00hr CYCLES

100.00hr TEST

2.338mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

100 hr

STANDARD SURFACE

SPINEL.  $\theta_0$ -8.30A.

CeO

SPALL

100 hr

COLLECTED SPALL

CeO

SPINEL.  $\theta_0$ -8.30A.

NI(W.M.)O<sub>4</sub> TYPE I

FACE CENTERED CUBIC MATRIX

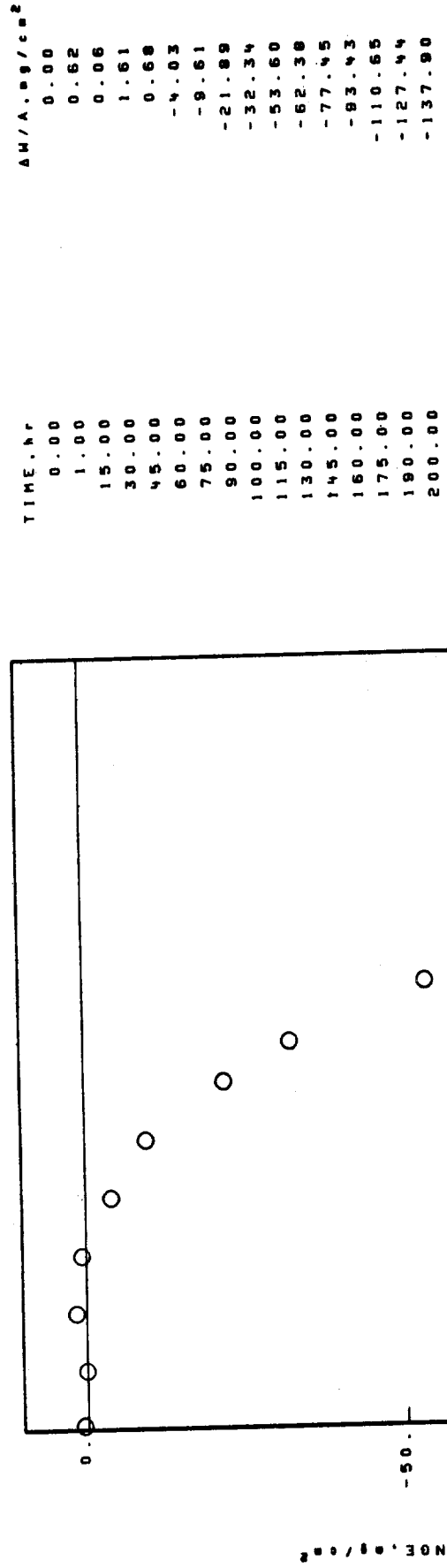
03 02-003-310-1

C. BASE CAST (TURBINE) ALLOYS

1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

MAR-M-509

SPECIFIC WEIGHT CHANGE DATA



C. BASE

CAS (TURBINE) ALLOYS

MAR-M-508

03 02-003-310-1

1100°C

1.00hr CYCLES

200.00hr TEST

2.330mm THICK

STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

SPINEL. 00-0.35A.

C.O

SPALL

200 hr

COLLECTED SPALL

SPINEL. 00-0.35A.

C.O

C.OH<sub>2</sub>

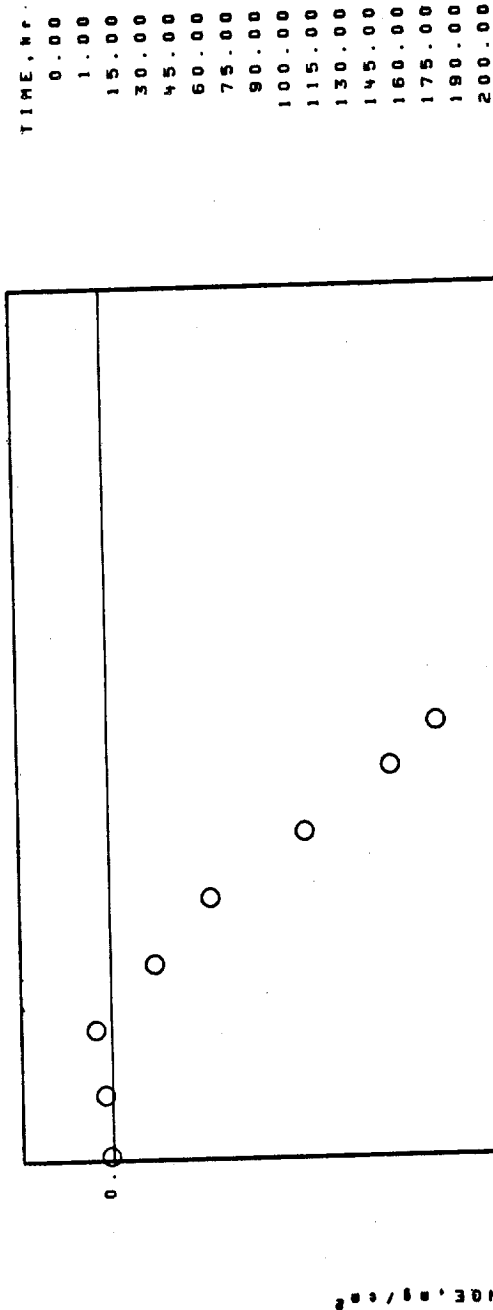


C. BASE CAST (TURBINE) ALLOYS

1100°C 1.00hr CYCLES 200.00hr TEST 2.327mm THICK STATIC AIR

MAR-M-509

SPECIFIC WEIGHT CHANGE DATA



C. BASE CAST (TURBINE) ALLOYS

HAR-M-509

1100°C 1.00hr CYCLES 200.00hr TEST 2.327mm THICK 03 02-003-326-4  
STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

C<sub>0</sub>O

SPINEL.  $d_0 = 8.35\text{\AA}$ .

SPALL

200 hr

COLLECTED SPALL

SPINEL.  $d_0 = 8.35\text{\AA}$ .

C<sub>0</sub>O

C<sub>0</sub>HO<sub>4</sub>

FACE CENTERED CUBIC MATRIX

CAST (TURBINE) ALLOYS

STATIC AIR

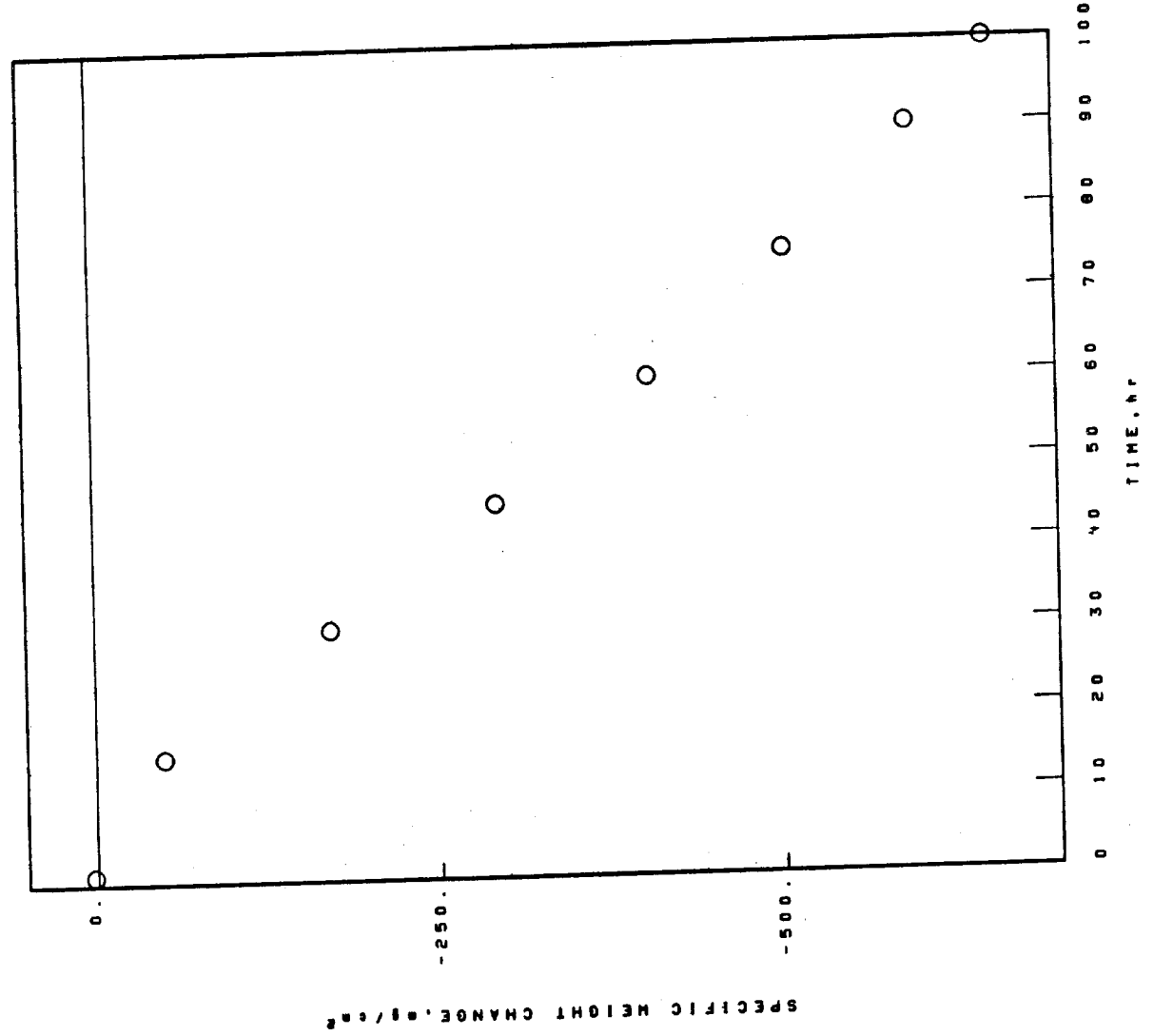
1150°C 1.00hr CYCLES 100.00hr TEST 2.651mm THICK

C. BASE

W1-52

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	ΔW/A, g/cm <sup>2</sup>
0.00	0.00
1.00	2.25
15.00	-49.38
30.00	-171.38
45.00	-282.62
60.00	-403.88
75.00	-503.75
90.00	-594.00
100.00	-650.60



C. BASE

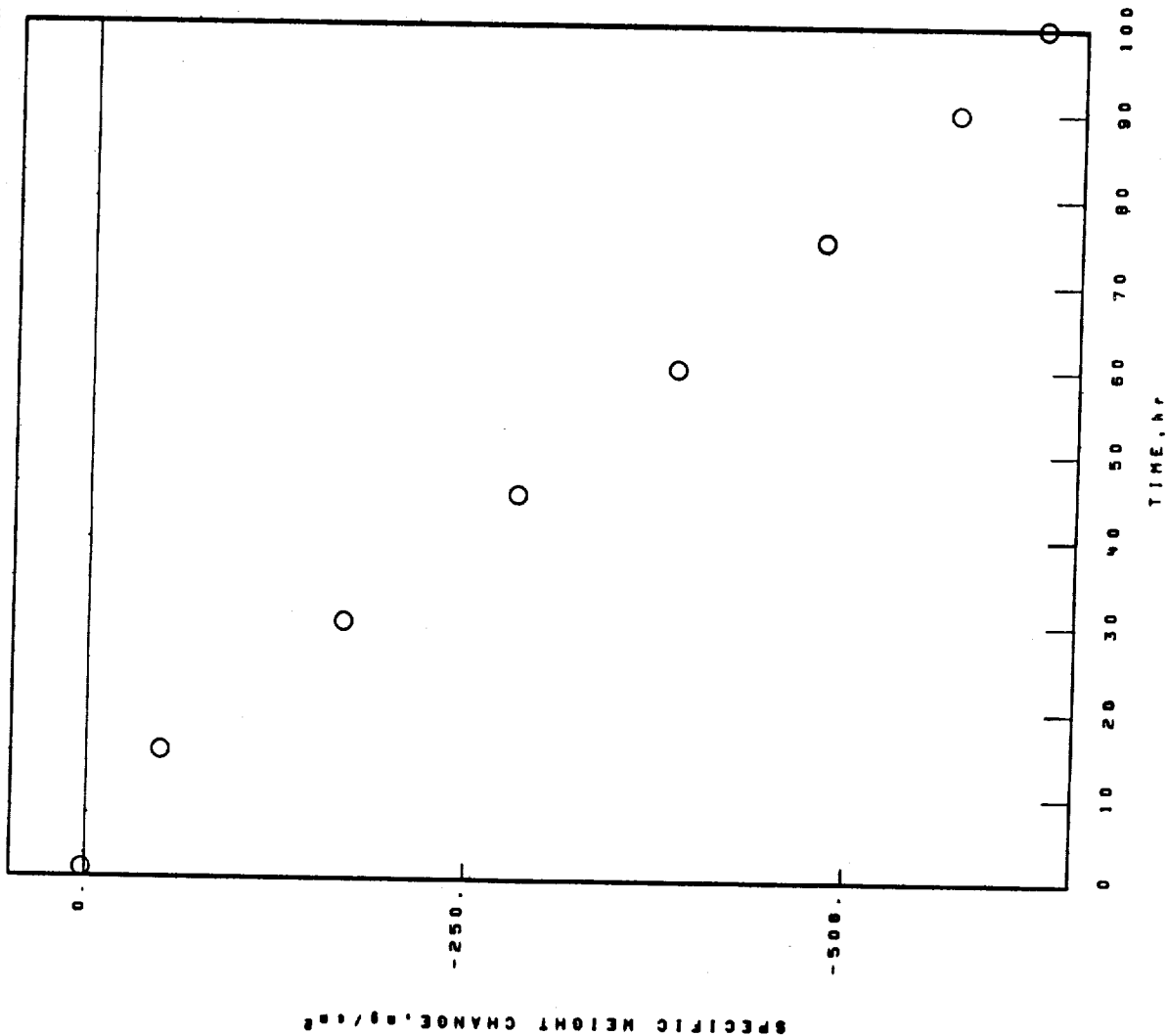
CAST (TURBINE) ALLOYS

03-02-002-105-5

WI-52

1150°C 1.00hr CYCLES 100.00hr TEST 2.657mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr  
0.00  
1.00  
15.00  
30.00  
45.00  
60.00  
75.00  
90.00  
100.00

$\Delta W/A, g/cm^2$   
0.00  
2.28  
-48.40  
-167.99  
-281.23  
-385.22  
-481.24  
-567.32  
-623.71

C. BASE CAST (TURBINE) ALLOYS 1150°C 1.00hr CYCLES 100.00hr TEST 2.657mm THICK STATIC AIR  
 MI-52

X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL. $\theta_0$ -8.35A.	CrO
Cr <sub>2</sub> O <sub>3</sub>	SPINEL. $\theta_0$ -8.20A.
Cr <sub>2</sub> O <sub>3</sub> 15-867	SPINEL. $\theta_0$ -8.30A.

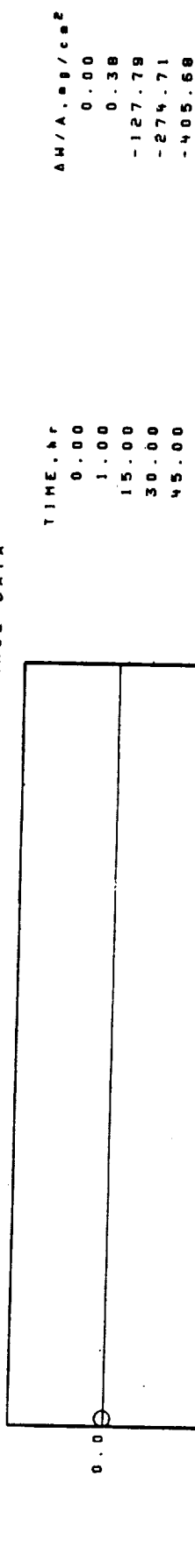
# C. BASE CAST (TURBINE) ALLOYS

03-02-002-470-3

WI-52

1150°C 1.00hr CYCLES 45.00hr TEST 2.328mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



C. BASE CAST (TURBINE) ALLOYS 1150°C 1.00hr CYCLES 45.00hr TEST 2.328mm THICK STATIC AIR  
WI-52

## X-RAY DIFFRACTION DATA

## SURFACE

1 hr

## STANDARD SURFACE

Cr<sub>2</sub>O<sub>3</sub>SPINEL.  $\theta_0 = 8.35^\circ$ .TRI(RUTILE).  $4(110) \gg 3.30^\circ$ .TRI(RUTILE).  $4(110) \gg 3.30^\circ$ .

## SPALL

1 hr

## COLLECTED SPALL

Cr<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

45 hr

## STANDARD SURFACE

SPINEL.  $\theta_0 = 8.25^\circ$ .Cr<sub>2</sub>O<sub>3</sub> 15-867Cr<sub>2</sub>O<sub>3</sub>

## FACE CENTERED CUBIC MATRIX

45 hr

## COLLECTED SPALL

SPINEL.  $\theta_0 = 8.30^\circ$ .Cr<sub>2</sub>O<sub>3</sub>Cr<sub>2</sub>O<sub>3</sub> 15-887

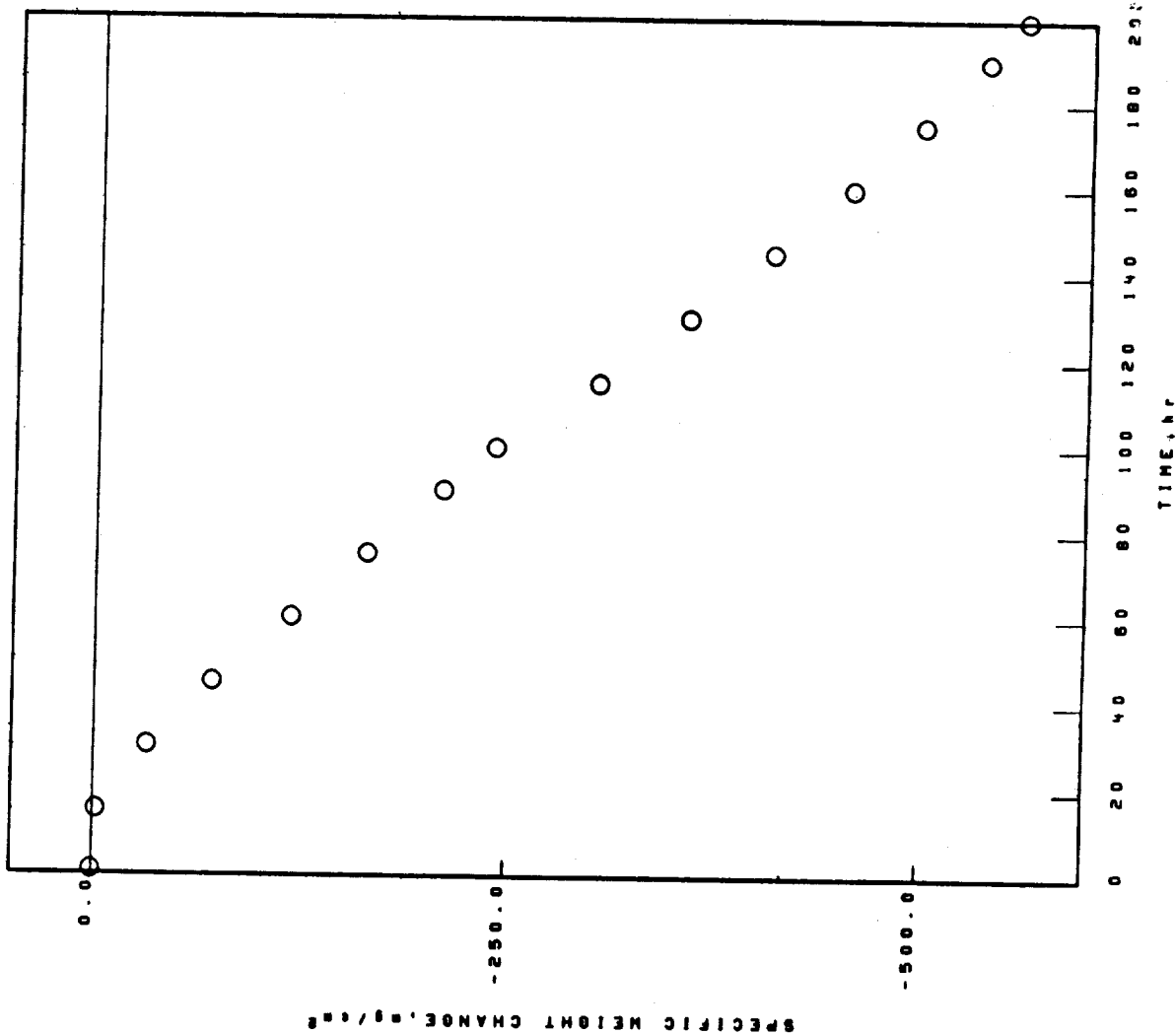
# C. BASE CAST (TURBINE) ALLOYS

03-02-002-469-3

W1-52

1100°C 1.00hr CYCLES 200.00hr TEST 2.332 THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.00
15.00	-1.67
30.00	-32.28
45.00	-71.19
60.00	-118.57
75.00	-164.15
90.00	-209.80
100.00	-241.47
115.00	-303.31
130.00	-357.48
145.00	-407.92
160.00	-455.22
175.00	-497.80
190.00	-536.24
200.00	-559.01



C. BASE CAST (TURBINE) ALLOYS  
 1100°C 1.00hr CYCLES 200.00hr TEST 2.332mm THICK STATIC AIR  
 WI-52

## X-RAY DIFFRACTION DATA

SURFACE  
 1 hr  
 STANDARD SURFACE  
 $\text{Cr}_2\text{O}_3$   
 SPINEL.  $\theta_0=8.35\text{\AA}$ .

## SPALL

1 hr

NO SIGNIFICANT SPALL OBSERVED

## FACE CENTERED CUBIC MATRIX

100 hr  
 STANDARD SURFACE  
 SPINEL.  $\theta_0=8.30\text{\AA}$ .  
 $\text{C}\cdot\text{O}$   
 $\text{Cr}_2\text{O}_3$

100 hr  
 COLLECTED SPALL  
 SPINEL.  $\theta_0=8.30\text{\AA}$ .  
 $\text{C}\cdot\text{O}$   
 $\text{Cr}_2\text{O}_3$   
 $\text{C}\cdot\text{WO}_4$  15-867

## FACE CENTERED CUBIC MATRIX

200 hr  
 STANDARD SURFACE  
 $\text{C}\cdot\text{WO}_4$  15-867  
 SPINEL.  $\theta_0=8.30\text{\AA}$ .  
 $\text{C}\cdot\text{O}$   
 $\text{Cr}_2\text{O}_3$

200 hr  
 COLLECTED SPALL  
 SPINEL.  $\theta_0=8.30\text{\AA}$ .  
 $\text{C}\cdot\text{O}$   
 $\text{C}\cdot\text{WO}_4$  15-867

## FACE CENTERED CUBIC MATRIX

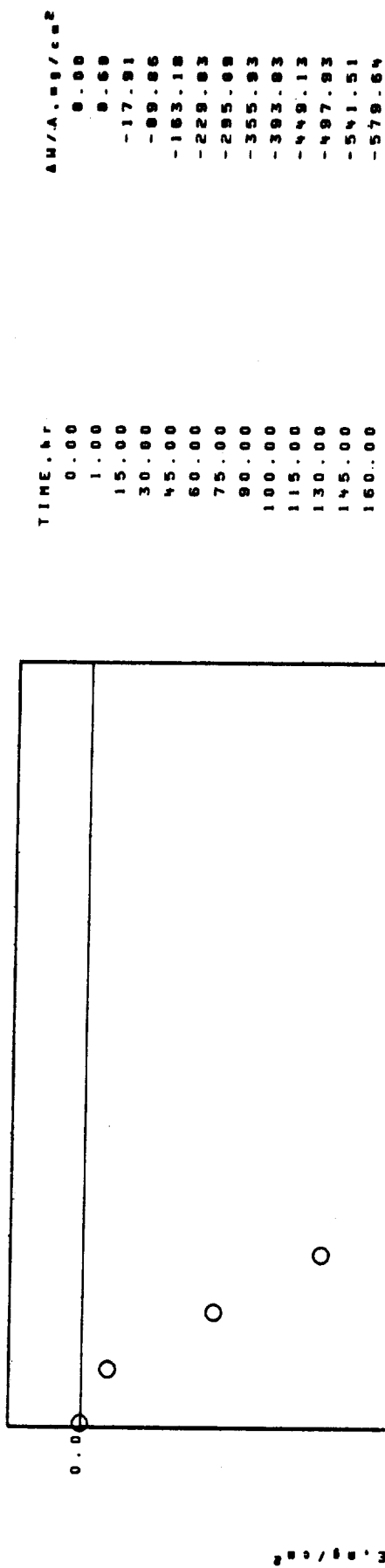
# C. BASE CAST (TURBINE) ALLOYS

03-02-002-393-3

NI-52

1100°C 1.00hr CYCLES 160.00hr TEST 2.322in THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



C. BASE CAST (TURBINE) ALLOYS 1100°C 1.00hr CYCLES 160.00hr TEST 2.322hr THICK STATIC AIR  
W1-52

## X-RAY DIFFRACTION DATA

SURFACE	SPALL
160 hr	160 hr
STANDARD SURFACE	COLLECTED SPALL
NI(W.M.)O <sub>4</sub> TYPE I	SPINEL. $\theta_0$ -8.30A.
SPINEL. $\theta_0$ -8.35A.	C.O
C.O	NI(W.M.)O <sub>4</sub> TYPE I
Cr <sub>2</sub> O <sub>3</sub>	

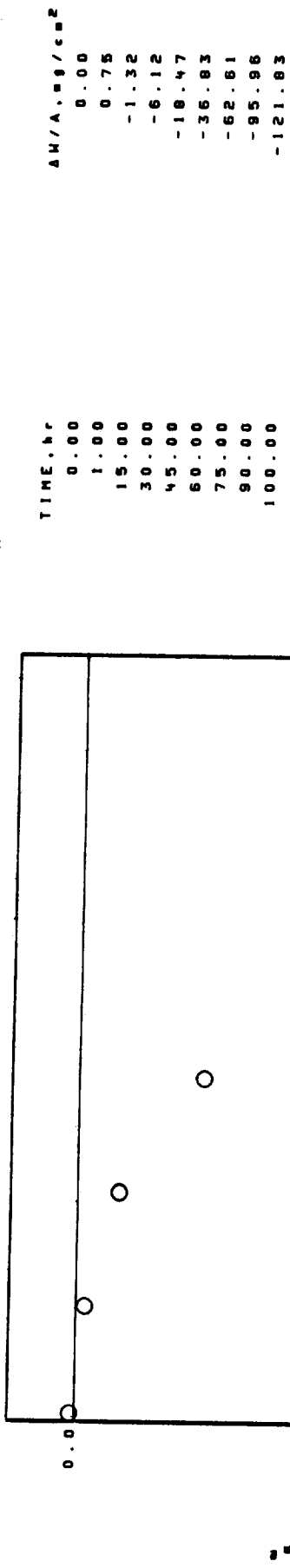
# C. BASE CAST (TURBINE) ALLOYS

03-02-001-105-3

X-40

1150°C 1.00hr CYCLES 100.00hr TEST 2.521mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



455

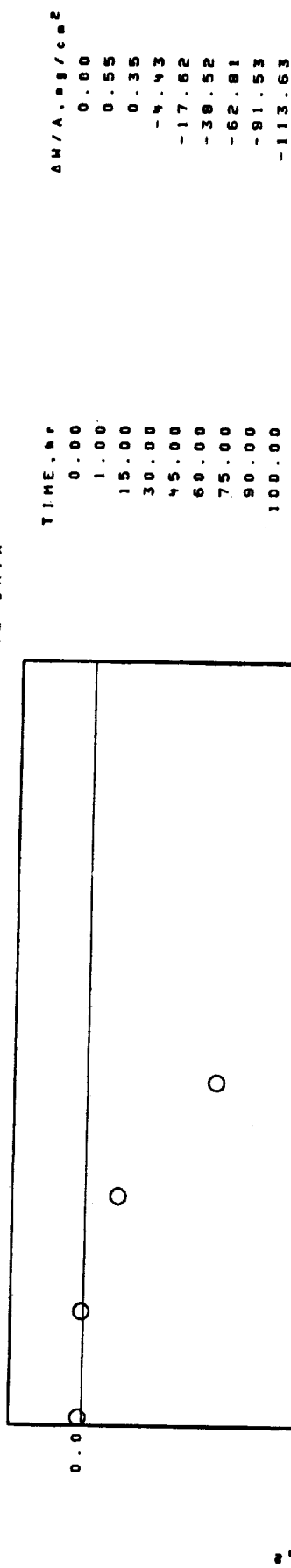
# C. BASE CAST (TURBINE) ALLOYS

03-02-001-105-6

X-40

1150°C 1.00hr CYCLES 100.00hr TEST 2.568mm THICK STATIC AIR

## SPECIFIC WEIGHT CHANGE DATA



03-02-001-393-4

CAST (TURBINE) ALLOYS

C. BASE

STATIC AIR

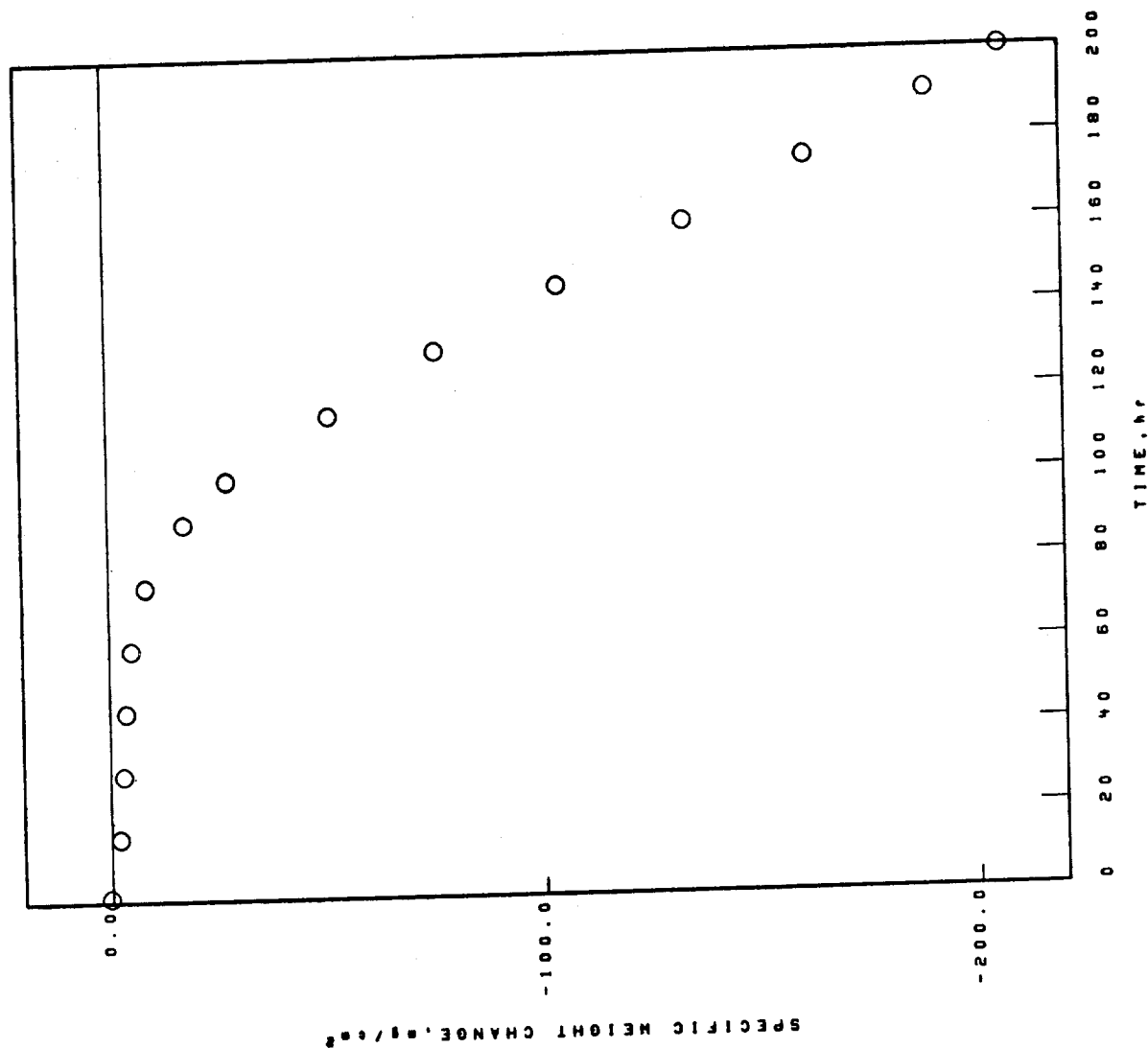
2.254mm THICK

1100°C 1.00hr CYCLES 200.00hr TEST

X-40

SPECIFIC WEIGHT CHANGE DATA

TIME, hr	$\Delta W/A, g/cm^2$
0.00	0.00
1.00	0.42
15.00	-1.88
30.00	-2.98
45.00	-3.70
60.00	-4.97
75.00	-8.53
90.00	-17.48
100.00	-27.50
115.00	-51.12
130.00	-75.88
145.00	-104.18
160.00	-133.31
175.00	-161.24
190.00	-189.17
200.00	-206.31



# C. BASE CAST (TURBINE) ALLOYS

03-02-001-393-4

X-40

1100°C

1.00hr CYCLES

200.00hr TEST

2.254mm THICK

STATIC AIR

## X-RAY DIFFRACTION DATA

SURFACE

200 hr

STANDARD SURFACE

CoO

SPINEL. 98-8.35A.

Cr<sub>2</sub>O<sub>3</sub>

SPALL

200 hr

COLLECTED SPALL

CoO

SPINEL. 98-8.30A.

NI(W.Mo)O<sub>4</sub> TYPE I



# Report Documentation Page

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16. Abstract This volume is the second part in a series of cyclic oxidation handbooks presenting cyclic oxidation data tested at NASA Lewis Research Center. It contains specific-weight-change versus time data and x-ray diffraction results derived from high-temperature cyclic tests for the remainder of high-temperature, high-strength nickel base $\gamma/\gamma'$ and cobalt-base turbine alloys tested at Lewis.					
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